Physical & Applied Sci. Serials

The TECHNICAL WORLD

VOL. I JULY, 1904 No. 5

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Modern Excavation at Panama . . . . *By* MALCOLM MCDOWELL

Auxiliaries of Engine and Boiler Rooms on Shipboard *By* FREDERICK D. HERBERT

People or Freight Underground? The Chicago Subway. *By* HENRY M. HYDE

Softening of Water for Steam-Raising Purposes *By* WALTER H. GREEN

Recent Battleship Designs . . . . . *By* W. S. LELAND, S. B., *Massachusetts Institute of Technology.*

Technical Value of the World's Fair . . . . *By* JOHN C. SMALL

The Ideal Foreman . . . . . *By* FREDERICK W. TURNER

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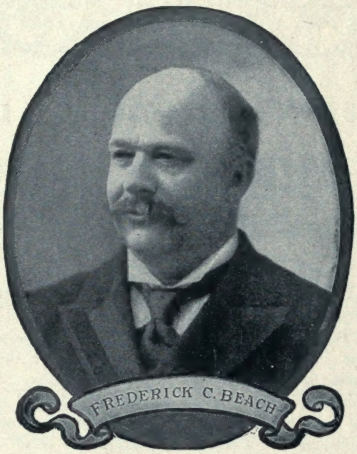

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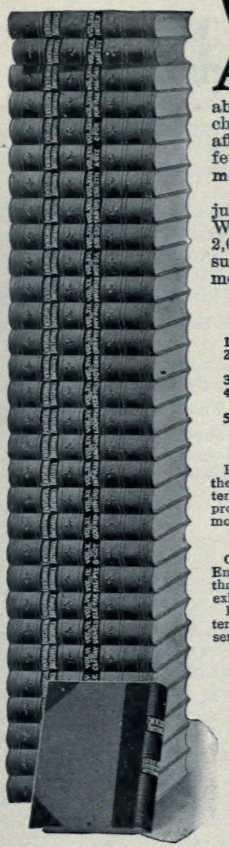

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THE TECHNICAL WORLD

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THE TECHNICAL WORLD is a monthly magazine, published the fifteenth of each month by the American School of Correspondence at Armour Institute of Technology, and devoted to the problems of the technical and industrial world, and a treatment of all matters of interest in Applied Science.

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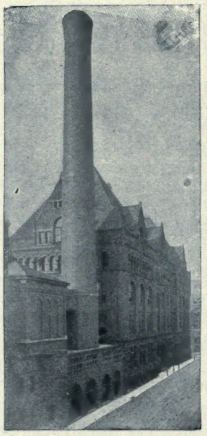

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The
Technical World

Volume I JULY, 1904 No. 5

Modern Excavation at Panama

A Description of the Machinery and Methods that will be Employed in Cutting across the Isthmian Divide

By MALCOLM McDOWELL

WESTERN MEN and Western methods will finish the Panama Canal. This prediction is based upon the opinions voiced by those who stand high in the engineering world, and is strengthened by the recent appointment as Chief Engineer of the Panama Canal, of John F. Wallace, General Manager of the Illinois Central Railroad. Those who know Mr. Wallace recall the many brilliant solutions of tough engineering problems he solved when Chief Engineer of the Illinois Central. They believe he will cleave a way through the isthmian divide in less time than the most optimistic Panama Canal enthusiast has set down, for he does not bow down and worship the dusty traditions of precedent, nor does he hesitate to jump the technical reservation and blaze new trails when occasion requires.

In short, with this Western engineer at the helm of affairs, with modern excavating and up-to-date material-handling machinery at his command, it is entirely safe to venture the prediction that the Panama cut will break all records in the construction of ship canals.

Photos supplied by courtesy of Isham Randolph, Chief Engineer, Sanitary District of Chicago.

The Isthmian Canal Commission, in its somewhat disappointing report comparing the Nicaragua and Panama routes, estimates that it will require two years of preparation for work, and eight years more to excavate through the 43,000,000 cubic yards of hard clay and soft rock in what is known as the Culebra Cut of the Panama Canal; but a party of Western engineers and contractors who traversed the route, viewing everything with critical eyes, figured that with the kind of machinery and brand of energy employed in constructing Chicago's big combination Ship and Drainage Canal, the Panama Canal could be finished in six to seven years.

"All we would want would be plenty of money and fever-proof hoboes," said one of the contractors. "The material to be excavated on the Panama route is easy compared to the mean, dynamite-defying, steel-proof, shovel-destroying, man-killing stuff which Ossian Guthrie's glacier piled up and rammed down on the line of the Drainage Canal."

The main channel of the Sanitary District of Chicago, commonly known as the Chicago Drainage Canal, is about 28 miles long, of which 9 miles are in solid rock. Over 12,000,000 cubic yards of solid rock, and nearly 30,000,000 cubic yards of the so-called "glacial drift," were excavated and heaped up on both

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sides of the channel. No excavation, 28 miles long, has revealed a more heterogeneous aggregation of solid matter. There were hard rock and soft rock; hard clay which had to be blasted, and obdurate dirt full of huge, ice-rounded boulders; sloppy muck, and a natural cement called "conglomerate," which sent several contractors into bankruptcy and half a dozen engineers to the verge of insanity. Every mile presented new problems in the excavation and handling of material. And they were solved, not by engineers, but by the contractors, whose originality in planning and superb audacity in execution made the Chicago Drainage Canal the center of attraction of the engineering world for many years.

These contractors built mighty mechanisms such as never before had been seen. They staked fortunes on untried devices, and won fortunes. Every penny saved in handling a cubic yard of material meant $400,000 profit. They "plunged" with that penny in view. Some of them found a nickel or a dime in every cubic yard; others broke up their experimental plants, sold them to the junk man for scrap iron, and applied for a receiver.

Out of all this, developed the wonderful machines and novel methods which excavated the Drainage Canal; and some of these machines and methods will cut through the Panama divide, unite the Pacific and the Atlantic, and make islands of the two Americas.

Excavation—that is, the breaking up and loosening of the rock and clay—will not be a difficult task on the Panama work. The problem to be solved relates largely to the removal of the material from the line of the channel. In some places this material must be lifted up and transported far back; in other places it can be heaped up alongside the excavation.

A TYPICAL CANAL CONSTRUCTION SCENE.
General View of Channel, with Cableways for Removing Excavated Material.

Cableways

Engineers who are acquainted with the isthmian situation say that the Lidgerwood cableways, with the dumping apparatus devised by Mr. Locker, a Drainage Canal contractor, and the movable incline of the type constructed by Mr. Heidenreich, another Drainage Canal contractor, will be much in evidence on the Panama work.

The cableway is a suspension bridge formed of a steel cable 2½ inches in diameter which stretches between two towers, one on each side of the cut. The

PHOTO BY A. WICKSTROM, U. S. S. "OLYMPIA."

DREDGES ON PANAMA CANAL NEAR COLON.

All this machinery formerly belonged to the French Company, and is going to decay.

system is not new; but the conditions that obtained on the Drainage Canal brought about a unique improvement. The towers were reared on great trucks whose heavy wheels ran on tracks laid parallel to the channel. These towers were 700 feet apart; one was 93 feet high; the other, 73 feet high. The whole apparatus—it was called a "machine"—was mobile, so that this suspension bridge moved forward with the advance of the work.

On the platform under the taller tower were the engines, boiler, dynamo, and other machinery. On the steel cable bridge, traveled the cable carriage that carried the pulley wheels and sheaves of the tackle which raised the loaded "skip"—an immense steel box—from the bottom of the channel. The arrangement of sheaves, pulleys, cables, and hoisting machinery, was so ingenious that the engineer in the power house on the platform could do almost everything but load the skip with the blasted rock. He could not even see the skip until it was swaying in mid-air.

A boy, with an electric push-button, gave him the signals—one bell, "stop;" two bells, "hoist;" three bells, "lower;" four bells, "run in;" five bells, "run out;" and other combinations—which enabled him to adjust the direction and speed of the skip so nicely that he could lift it, run it to the "spoil bank," dump it, and return it with amazing accuracy and celerity.

While one loaded skip was in the air, moving rapidly to the dumping ground, the "muckers"—laborers—loaded other skips. The skip in flight did not stop. It was dumped while moving, to be instantly brought back directly over the

MAP OF PANAMA CANAL ROUTE.

work. Then it swooped to the ground, where half a dozen muckers pounced on it and unhooked the great chains, which were instantly hooked to another loaded skip, and this in turn whisked aloft without the loss of a second. Every time a skip "took the air," it carried away 90 cubic feet of material, traveling along the cableway at the rate of 1,000 feet a minute. The cableway was used exclusively

for handling rock. On the Panama Canal, it is believed that it will be employed also on the earth sections, for it can be extended to carry material long distances from the "face" of the work.

The Heidenreich Incline

The Heidenreich incline, or a "machine" closely resembling it, will probably be used to carry off the earth and clay. The entire framework of the machine moves back and forth on trucks which travel on rails laid parallel with the channel. The two tracks carrying the dump cars that speed up and down the incline, extend down into the excavation. Like the cableway, the Heidenreich machine is self-contained. It carries with it a power plant which not only operates the cars but moves the whole apparatus forward with the progress of the work. The broken rock carried away by the cableway is loaded into the skips by hand; the earth and clay conveyed from the scene of activity on the incline are loaded into the dump cars by steam shovels.

LIDGERWOOD CABLEWAYS IN OPERATION.

Steam Shovels

The steam shovels used on the Drainage Canal attained enormous proportions, some of them weighing 75 and 80 tons. They too moved back and forth on rails. They were the "bull-dogs" of excavating machinery. When they bit into the tough, hard-yielding clay, something had to give way. Every mouthful measured from 2½ to 3½ cubic yards. Some of the dippers were fringed with wicked-looking steel tusks which literally ate the ground; and the mighty machine trembled and growled until the tusks had buried themselves, dipper deep, in the clay.

Steam shovel men acquired extraordinary skill handling these cyclopean mechanisms. With levers, valves, and brakes, they could worm the steel tusks caressingly under a huge boulder, rend it from the clay matrix which had enveloped it for ages, and toss it jauntily into the waiting dump car.

Two cars were used on the Heidenreich incline, and they rolled up and down faster than the swiftest elevator travels in modern sky-scrapers. When one car was loaded, the signal was given, and the car sped away to the highest point of the incline, the empty car meanwhile traveling as rapidly toward the work. The loaded car ran out upon a "tipple"—a sort of teeter-board. Immediately it passed the center of gravity, the car was thrown forward and its contents were dumped. There was a pause of a few seconds—just long enough for the steam shovel to load the empty car. Then the steel cable hummed again, and the cars passed each other half way on the incline.

One of these machines conveyed 1,000 cubic yards of earth in 10 hours.

Cantilever Conveyors

It is probable that some "cantilever" conveyors, like those which did such effective work on the rock sections of the Drainage Canal, will be used on the isthmian work. They look like tipsy swing bridges. One arm of the bridge stretches over the work, the other over the "spoil" bank. The bridge slants so that the inside arm is much lower than the outside. The cantilever conveyor is from 350 to 400 feet long, and is carried on a tower which rises from a platform. The machinery for lifting the material and moving the conveyor is installed on this platform. On this slanting bridge, runs a car which is hauled at great speed up and down the incline by an endless steel cable. The material is loaded into the car by hand or by steam shovel; and the machine has lifted out over 900 cubic yards of material in ten hours.

HEIDENREICH METHOD OF EXCAVATION

Revolving Derricks

One of the most interesting of the devices used on the Drainage Canal was the revolving derrick, whose long boom reached out from a steel tower which stood on a turntable. The skips or hods were filled, lifted up, and swung around on the ends of the booms over the bank,

HIGH-POWER DERRICK USED IN CHANNEL EXCAVATION.

STEAM SHOVEL DUMPING INTO CAR.

where they were automatically dumped.

Pneumatic Dumps

Pneumatic dumps similar to those de-

A CHANNELING MACHINE. CAPABLE OF CUTTING A SMOOTH, PERPENDICULAR FACE IN ROCK.

veloped on the Drainage Canal will undoubtedly be used on the Panama work. These "dumps" are trains of side-dumping cars running on narrow-gauge tracks, which worm their devious routes up and around until the roadbed looks like a "loop-the-loop" affair. All the cars are connected by rubber air hose with a little locomotive whose intense energy and push are out of all proportion to its size. When the earth-filled train reaches the dumping ground, the engineer turns a valve, and instantly every car makes a comical bow, dumps its contents, and slams back to stability again. The dumping is effected by the pistons of compressed-air cylinders under the cars.

Drills and Channeling Machines

Compressed-air drills and steam "channeling" machines will chuckle and click under the tropical sun when the Panama work begins. The channeling machines became famous on the Drainage Canal. They were used on the rock cut, whose smooth sides bear testimony to their effective work. A channeling machine is a great chisel clamped to the free end of a piston rod of a vertical engine. Its office is to cut a deep, wide gash down into the solid rock on the line of the edge of the channel. The machine consists of a vertical boiler and engine mounted on a heavy car which moves automatically back and forth on rails laid alongside the edge of the canal. As the chisel works up and down, the car slowly moves forward and back until the huge

chisel has buried itself four to six feet in the rock.

"Channeling" is done in connection with air or steam drills which drive holes a few feet apart across the work, from one side to the other. Dynamite cartridges are placed in the holes, and are exploded by electricity. The effect is to blow forward a cross-section of the work. The gash cut by the channeling machine facilitates this operation, and at the same time gives a smooth finish to the sides of the rock cut.

Dredges

Steam dredges of great capacity will be used for sea-level work on either end of the Panama Canal; and "sand-suckers," as the hydraulic dredges are called, will aid in keeping open the harbor channel.

Up to this time the constructive work on the isthmus has followed closely the methods that were used in the excavations of the Suez Canal. Now that the American Government has taken hold of the project, there will be the long-wished-for opportunity of closely comparing American and European engineering methods.

When the Panama work is well under way, the great cut will be cobwebbed overhead with the taut cableways; its sides will be alive with cars racing up and down the latticed incline; and the grunts and groans of a hundred great steam shovels will be the double bass of the industrial chorus, in which the merry chuckle of rock drills, the hissing of escaping air and steam, the humming of pulleys and sheaves, the snorting and

SIX-YARD DIPPER OF STEAM DREDGE.

puffing of the little engines pushing pneumatic dump cars, and the ringing of the channeling machines' broad chisels, will keep time to the beat of the salvos of explosions when the dynamite "lets go."

CHRISTIE & LOWE METHOD OF EXCAVATION.

Auxiliaries of Engine and Boiler Rooms on Shipboard

A Description of the Secondary Equipments without which the Main Engines would be Useless

By FREDERICK D. HERBERT

Editor, *Marine Engineering*

WHILE the main engines and boilers on board ship perform the real work of propulsion in the generation of steam and driving the shaft, yet, unless these are adequately equipped with auxiliary machines of proper design and properly connected up, the main engines would be absolutely valueless. Many a delay is caused by a breaking-down of one of these smaller machines; and upon the experience of the designer who lays out this part of the work, and the care with which the engineer looks after the operation of these auxiliaries, will depend the successful running of the ship, and her earning capacity to her owner.

We may liken the working of a steam plant, in a measure, to that of the human body. In the first place, they both depend upon heat as the source of energy; and if engineers, in caring for marine engines, boilers, and auxiliaries, would exercise some of the rules observed in taking care of the body, many delays, breakdowns, and repairs would be avoided.

It is in reference, however, to auxiliary equipment that these remarks are directed. We shall assume that the reader is familiar with the method of generating steam in the boiler, and with the passage of the steam to the engine, where it expands in the cylinders and causes the shaft to rotate. The passage of this heat is indeed most interesting; but we shall take up its history at the point where the steam leaves the low-pressure cylinder, and follow it until it is returned to the boiler.

Surface Condensers

Let us assume that we are on board a small modern ocean steamer fitted with two cylindrical Scotch boilers and with a triple-expansion engine of about 1,200 indicated horse-power. The surface condenser is built in the back framing of the engine, and consists of a cast-iron shell containing a nest of several hundred brass or copper tubes held horizontally between two plates in the end of the condenser. The space between these plates (or "tube sheets," as they are called) and the shell of the condenser, is air-tight, with an opening at the top to admit the exhaust steam, and at the bottom to carry off the condensed water to the air pump. Through these tubes, water is circulated by means of a pump which is capable of handling a large amount of water under light pressure. The general practice is to use a centrifugal pump for handling this circulating water. The "runner," which revolves inside a cast-iron casing, is much like the blades of a fan, and draws the water in at the sides of the casing around the shaft, and discharges it through a pipe connection at a point of the greatest diameter of the casing. This circulating water is taken through an inlet valve in the bilge of the ship; passes from left to right through the lower half of the tubes, and from right to left through the upper tubes; and is finally discharged overboard at a point a little above the water line of the ship. The steam, striking the tubes cooled by the water, is condensed, and the heat of the steam is carried off in the circulating water. If steam fills an air-tight recep-

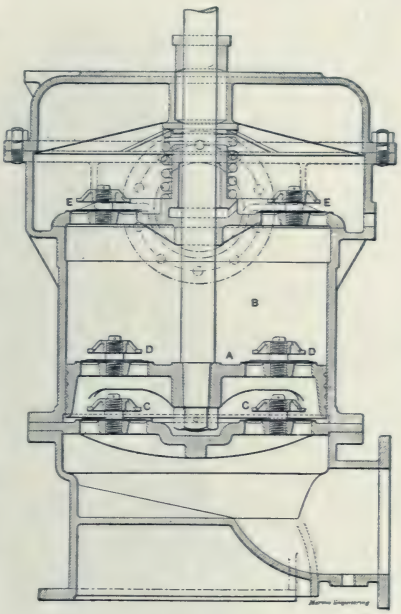
tacle and is condensed, a vacuum or pressure less than that of the atmosphere is formed. Thus, by the use of the condenser and the air pump, which pumps out the condensed steam, the exhaust pressure of the engine is less than that of the atmosphere. This vacuum is equivalent in general practice to about 25½ inches of mercury.

There are several other forms of surface condensers. Some are built independently of the main engine, and in that case the shell is made of brass or steel plates. A jet condenser is used only when the ship runs in fresh water. In this type of condenser the steam enters a vertical cylindrical vessel; and the cold water, which is let in at the top, flowing through a pierced plate, mixes with the steam and condenses it.

Great care must be exercised in keeping the condenser air-tight. The ends of the tubes are packed generally with a wick, which is held in place by a screwed ferrule. Condensed steam always carries with it more or less oil, some of which is deposited on the outside surface of the tubes. It is therefore necessary to examine and clean these tubes occasionally. If the condenser leaks, the vacuum, in the first place, will be destroyed, and salt water circulating about the tubes will leak in. The salt water, mixing with the feed water, will be carried to the boilers; and a crust of salt will eventually be deposited on the internal surfaces, which is very injurious to the boilers.

Air Pumps

Passing now to the next device for taking care of steam, we come to the air pump. This is generally a single-acting pump of about half the stroke of the main engine, and connected by levers with the crosshead of one of the main-engine cylinders. As already stated, the purpose of this pump is to remove the condensed steam from the condenser. There is always present a certain amount of air and vapor, which is also handled by this pump. The air pump maintains the vacuum created by the condenser. The pump is generally fitted with foot valves (CC in accompanying diagram), bucket valves (DD) in the plunger (A), and head valves (EE) at the top. On the upstroke of the plunger, the vacuum is created between the plunger and the foot valves, and, when this is lower than the vacuum in the condenser, the foot valves will open and the water and vapor from the condenser will flow in. On the down-

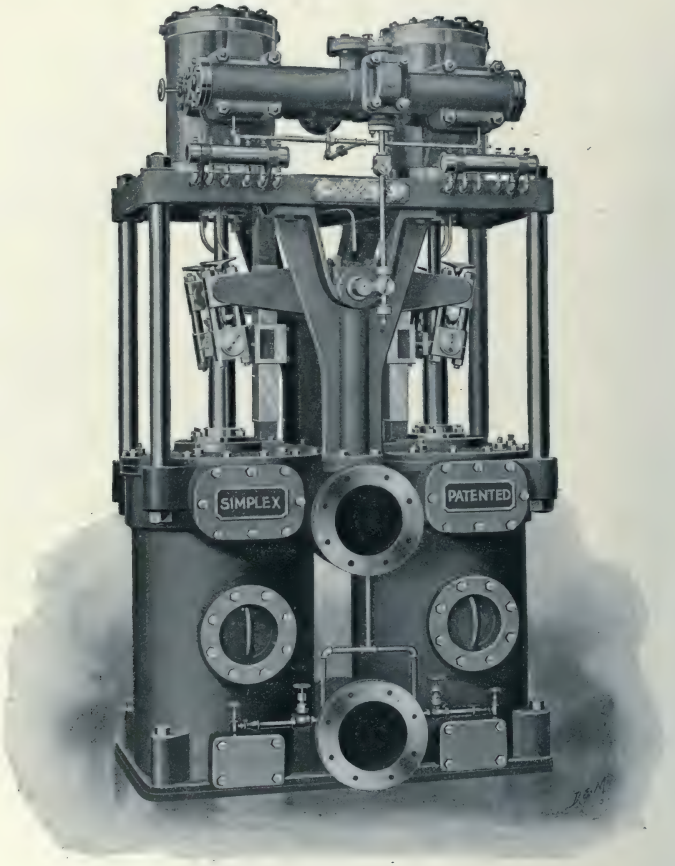


Section through an Air Pump. Marine Direct-Connected Type.

stroke, these foot valves will close and the charge will pass through the bucket valves in the plunger into the space B, and on the next upstroke, this same charge will lift the head valves and flow into the hot well.

There are several disadvantages in running one of these air pumps at high speed. In the first place, it takes time for the valves to lift, so that, when the speed is very great, the foot and head valves hardly have time to rise on the upstroke before they are closed on the downstroke. A specially designed direct-connected pump is sometimes used where the engine runs at high speed; but the usual type is an independent duplex air pump with a steam cylinder directly above each air cylinder. The advantages of the independent air pump—besides the

fact that it is slow-running—are, that the vacuum can be controlled regardless of the speed of the main engine, and that the pump can be started up and the vacuum created before the throttle of the engine is opened; whereas, with the direct-connected air pump, the engine must be run for several minutes before the pump can create a good vacuum.



INDEPENDENT TWIN-CYLINDER BEAM AIR PUMP.

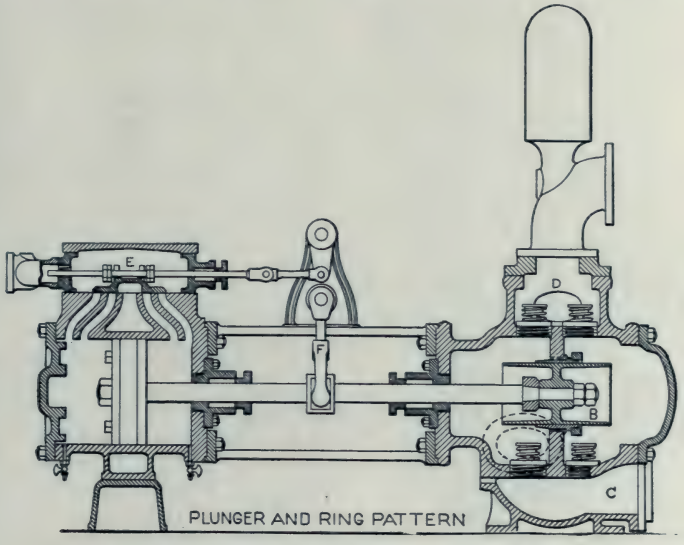
Oil Filters

The air pump discharges to the hot well. This, in its simple form, is merely a reservoir from which the feed pump draws water to supply the boilers. Some of the oil in the exhaust steam has been deposited on the condenser tubes, but most of it remains; and it is at this point that the engineer endeavors to extract the remainder, oil being very bad for boilers. The nearer he can get to feeding pure water to the boilers, the fewer repairs there will be necessary to make on them. Oil, salt, mud, or any other foreign substance, even air, will cause trouble on the internal surfaces of boilers. One end of

the hot well is fitted as a filter to remove the oil. The filtering substance may be hay, sponges, or other oil-absorbing fabrics. In the Navy, frequently, special filters are installed, the discharge from the air pump being caused to fall through a sectional tank which is filled with charcoal in bags; in other cases, filters are fitted between the feed pump and the boiler, and consist of chambers filled with cartridge or absorbent material through which the feed water is driven under pressure.

part of the exhaust steam from the auxiliaries. It is seldom, however, that a temperature of over 130 degrees is obtained by these methods. Sometimes the steam discharged from the auxiliaries is exhausted directly into a closed heater (where the steam and feed water are in direct contact) placed in the upper part of the engine room, the water being raised from the hot well by a separate pump.

The most approved method of heating feed water is by means of a series of



SECTION THROUGH STEAM PUMP OF PLUNGER TYPE.

Feed-Water Heaters

The temperature of the feed water should be as high as is possible, because, as is generally acknowledged, the nearer this temperature approaches that of the water in the boiler, the less straining will the boiler be subjected to as a result of the unequal heating of the plates. The usual temperature of the discharge from the air pump is between 100° and 112° Fahrenheit.

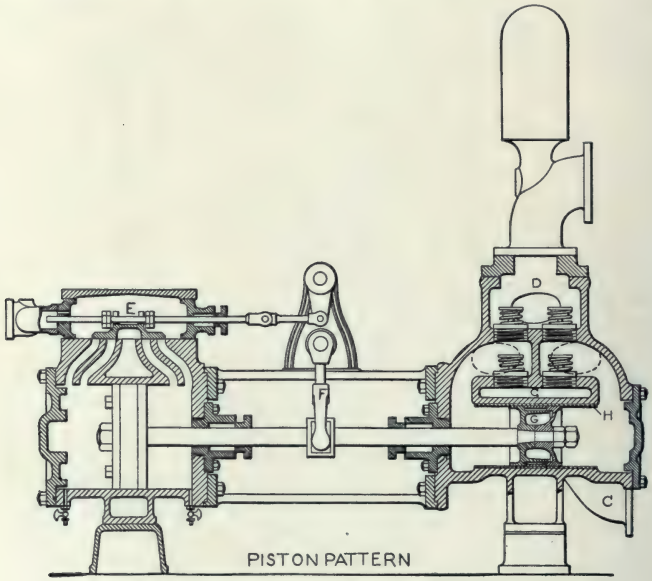
To heat the feed water, many different systems are used. The simplest of these is to lead the drains from the steam-heating system and auxiliary machinery direct to the hot well; another is to admit heaters, or "step-up" heaters. The first one is a surface heater—something like a small condenser—through which passes the exhaust from the auxiliaries; the second and third heaters are of the contact type. In the second, the steam is taken from the second receiver; and in the third, steam from the first receiver is taken in. Sometimes a fourth heater is used, and in this the steam of boiler pressure is admitted.

It will doubtless be asked, what is to be gained by taking steam out of the engine to heat up the water, there being just as much heat removed from the steam as is absorbed by the water. This

is perfectly true; but for mechanical reasons before mentioned, such as relieving the pressure in the boiler due to unequal heating, the best practice calls for heating the water to a high temperature.

Boiler Feed Pumps

We have now but to consider the boiler feed pump, and the chain of auxiliaries through which the condensed steam and water must pass between the engine and the boiler will be completed. Nowadays the type of pump used is the so-called "direct-acting." Thus, there are no connecting rods or fly wheel, and the water plunger is at the opposite end of the piston rod from the steam piston. The usual type of pump for marine service is the "duplex," that is, having two steam and two water cylinders. The steam cylinders, with their valves, which are usually of the piston type, are cast abreast of each other; and the two water cylinders, with common valve chambers above and below, are made in one casting. There are many forms of valve-actuating devices, and it will be evident that all these must be of good design and nice regulation, for, as there is neither crank nor fly wheel, the length of the stroke must be controlled by the valve. In the duplex type, the valve stem for steam cylinder No. 1 is actuated by an arm on the piston rod of No. 2; and similarly for the valve on steam cylinder No. 2. In smaller plants the single cylinder is used. Both types are double-acting. Frequently, when working against a very heavy pressure, an outside-packed plunger type is used on the water end. Single as well as duplex pumps are built of both the horizontal and the vertical pattern, the latter being especially suitable where floor space in the engine or boiler room is scant. Some of the larger-sized pumps are built with compound-tandem steam cylinders.



SECTION THROUGH STEAM PUMP OF PISTON TYPE.

The ordinary type of feed pump is heavy in all of its parts. This is the principal auxiliary which the engineer desires to have more than necessarily strong. The later styles are very great

improvements over the older ones, and many pumps are now built with wrought-iron or steel frames connecting to the water and steam ends, instead of heavy castings.

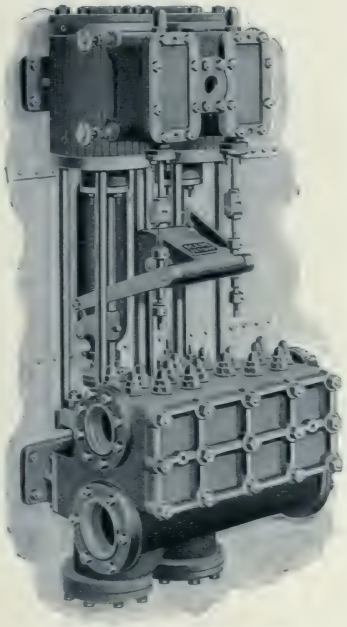
The steam pressure on the steam side is evidently the pressure against which the water must be forced into the boiler by the plungers. To overcome, however, the friction of the pump and of the water as it passes through the piping, elbows, feed heater, etc., it is necessary to have the steam cylinder of greater diameter than the water cylinder. A thumb rule for the proportion of cylinders would be to make the steam cylinder 1½ times the diameter of the water cylinder. The speed for running the feed pump is generally regulated automatically by means of a float placed in a hot well of the filter box and attached through rods to the throttle of the pump, so that when the tank is full the pump will run fast, and when the tank is empty the speed will be slowed down.

On many vessels a boiler feed pump is attached to the crosshead of the air pump, which is driven through levers from the main engine. A frequent practice is to fit the boilers with steam injectors for boiler feed. These, however, are used most in cases of emergency, as they must of necessity be run rather intermittently and they require considerable attention. An extra feed pump—called the "donkey feed"—is always installed, so that in case the main feed for the injectors should fail, there would still be a means of getting water into the boiler. This donkey feed is connected up to various systems of piping; and, where only a few pumps are installed, can perform almost any service, such as boiler, ballast, fire, bilge, circulating water, condenser, and ash ejector.

The Hydrokineter

When getting up steam to facilitate the circulation of water in the boiler, an instrument called the "hydrokineter" is sometimes fitted in Scotch boilers. This takes steam from above, and injects it through a nozzle into the water at the bottom of the boiler. If steam is up in one boiler, and it is wished to raise it in the second boiler, circulation through boiler No. 2 is increased by connecting the donkey pump to the hydrokineter.

Before passing to other auxiliaries, the necessity of maintaining a circulation of pure, fresh water should again be impressed upon the reader. The life of the boiler will be lengthened, its efficiency greatly increased, and the repairs cut down enormously, if all salt, mud, grease, or deposits of any kind are removed from



Duplex Vertical Water-Feed Pump.

the feed. Many kinds of water that are clear when cold, contain soluble salts which will be precipitated on heating. In other kinds of water containing impurities in solution, and where the water contains grease or mud, a scum will be formed upon the surface when the water is heated. For the purpose of removing both the precipitated and the surface foreign matter, blow-offs are provided at the bottom and at a point near the water line, by the use of which the deposit or the scum may to a certain extent be removed by opening the respective valves.

People or Freight Underground?

A Gigantic Engineering Enterprise Carried Out while Chicago Slept

By HENRY M. HYDE

Editorial Writer on the *Chicago Tribune*

IN BOTH NEW YORK AND CHICAGO, great under-street tunnel systems are rapidly nearing completion. The fundamental ideas on which the two systems are based are exactly opposite. They attack the problem of street congestion from radically different standpoints.

The New York vs. the Chicago Idea

The New York tunnel system is built for the transportation of passengers; the Chicago system for the underground handling of the city's freight.

It will take the experience of several years to demonstrate how far the Chicago idea is practically correct—how far it will go towards relieving the congestion that now makes foot travel on the down-town streets inside the loop a slow and dangerous method of progression. From the standpoint of ideal conditions, however, no one will question its being much the better plan.

The streets for the people! The underground tunnels for freight!—that, in a nutshell, is the position of the promoters and builders of the tunnels of the Illinois Tunnel Company. Let the people have the sunlight and the air and the unrestricted space on the street levels; let them avoid climbing up and down the long flights of stairs; let them go where they please on the surface of the ground, without its being necessary to keep dodging heavily loaded trucks, coal wagons, and ash carts. And make all this possible by taking all freight, coal, and ashes down into the tunnels, twenty-five feet below the surface, where they can be handled quickly and easily, at the same time avoiding the crowding and the littering of the streets that would otherwise be inevitable.

To the general public, and particularly to engineers, the idea may seem to be a somewhat visionary one; but the tunnel company has already spent something like ten millions of dollars as proof of its belief that the plan is a thoroughly practical one. This should be quite sufficient to entitle it to a fair trial and an unprejudiced hearing.

Quiet Methods in Chicago

In New York the building of the tunnel system has been marked by the greatest possible amount of publicity. The excavation of almost every shovelful of dirt has been hailed by a column or two in the newspapers. In Chicago, on the other hand, there has been practically no publicity. Fully a dozen miles of the subway were entirely completed before one out of ten citizens of the city knew that a tunnel system was in process of construction. Even now, when the company has made contracts for the hauling of freight, ashes, and coal with many large business houses, it is well within the facts to say that not more than half the people of Chicago know of its existence.

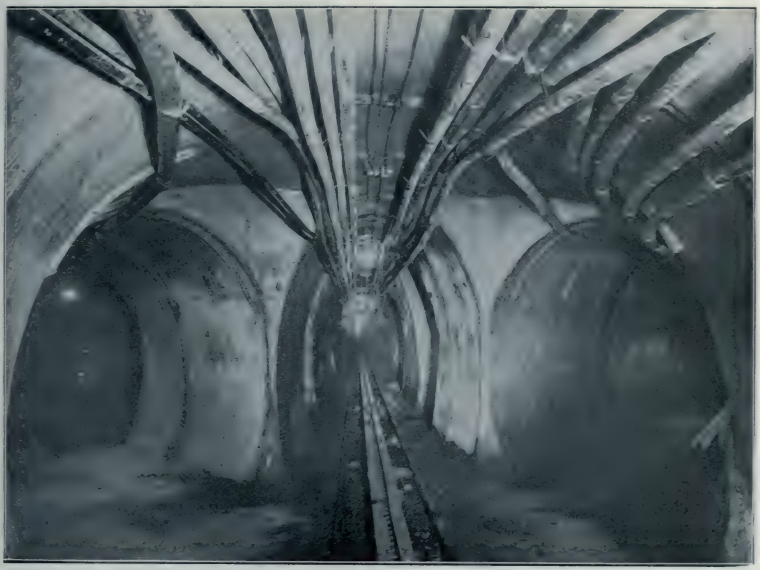
The fact that it was possible to work nearly a thousand men for three years, to lift to the street level the hundreds of thousands of square yards of material excavated by the tunnel miners, and to dispose of it without for a moment adding to the congestion of the streets, is a sufficient proof of the ability of Chief Engineer George W. Jackson and his associates. For years, thousands of people saw once or twice a day the little elevator houses standing at such prominent street corners as Lake and State streets, without having any idea of what they meant or for what purpose they were used. But

it was through these little houses that all the dirt taken out of the tunnels was raised and loaded into wagons, the work being done after dark, so as not to interfere with the regular traffic.

For Telephone and Railway

Primarily, at least so far as appears on the surface, the tunnels were built for the purpose of carrying the trunk lines of the Illinois Telephone & Telegraph Company, which, operating the automatic telephone system, already serves more than 5,000 subscribers, doing away altogether with the "central exchange operator" or "hello girl." Five years ago—in February, 1899—the city council passed an ordinance granting the use of the streets to a telephone company to be operated in opposition to the old Bell Company. It was under this ordinance that the tunnels were built. Whether the idea of using them for the transportation of freight was a later one, is uncertain. At any rate it was not until July, 1903, that the company, having reorganized under the name of the Illinois Tunnel Company, secured an amended ordinance from the city giving it permission to install an electric railroad in its tunnels for the transportation of freight and commodities of all kinds.

A large part of this road has already been built, the third-rail system of power transmission being used; and the company is about to close contracts for 150 electric locomotives and 3,000 freight cars.



CABLE SYSTEM OF THE ILLINOIS TUNNEL COMPANY.
Looking North on Fifth Avenue, Corner of Monroe Street.

What the Tunnel Railways Will Do

Here are a few of the ways in which the company expects to find business for itself, and at the same time to relieve the congestion of the surface streets:

It will serve the purpose of carrying coal to down-town office and business buildings, and removing the resulting ashes and other debris. It is estimated that about 4,000,000 tons of coal are now burned annually inside the loop, most of this vast quantity of fuel being at present delivered by team. Already—and its work in this direction has just begun—the company has contracted to haul the

coal and ashes for sixty-five of the largest buildings in the down-town district; and there seems to be no reason—the economy and cleanliness of its work being considered—why it should not eventually put practically all this work below the surface of the ground. In addition to ashes, there is an enormous amount of waste paper and other rubbish originating daily in the big down-town buildings, which at present helps to litter the streets and which the tunnel company will be able to handle advantageously and economically.

damage done to the street pavements by these heavily loaded wagons and drays.

By January 1, 1905, the Illinois Tunnel Company will have facilities for handling underground not less than 50,000 tons of freight per day. Already architects, in the designing of wholesale and manufacturing buildings within the loop, are beginning to provide for the construction of sub-basements forty feet below the surface, on a level with the tunnels, these sub-basements being intended for use as freight yards or shipping rooms for the firms occupying the buildings.

FREIGHT TRAINS AT STREET INTERSECTION.

Another purpose served will be the hauling of freight to and from freight depots and business houses. Chicago is one of the greatest railroad centers in the world. No less than twenty-five trunk lines of railroad radiate from it. The aggregate annual volume of freight tonnage is enormous almost beyond computation, and it is all received and distributed from six freight depots, which are located within a territory only one and a half miles square. At present this freight is handled in trucks, the enormous number of which constantly block traffic, to say nothing of the daily

Details of Construction

The freight cars of the company are of steel and iron construction throughout, and each car measures twelve feet over all. They are of the double-truck, eight-wheel type, and are built as combination cars, which can be used either as gondolas or flat cars. As a box car, one of these vehicles will measure 48 inches in width, and will stand 63 inches above the rail; while the box will be 10 feet 6 inches long. The weight capacity of each car is 30,000 lbs. The cars are so constructed that they can turn on a curve of fifteen-foot radius. It is said that they

will carry anything that can be passed through the door of any regular freight car now in use.

The tunnels themselves are of horseshoe shape, with walls, roofs, and bot-

Electric Locomotive and Loaded Freight Car.

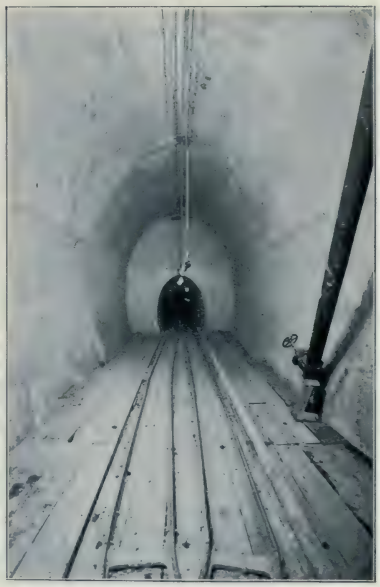
toms of solid concrete. They are of two types—trunk conduits, 11 feet 2½ inches wide and 12 feet 6 inches high, inside measurement; and lateral conduits, 6 feet wide and 7 feet 6 inches high, inside measurement. The smaller tunnels have 13-inch bottoms and 10-inch walls and tops; the trunk tunnels, 21-inch bottoms and 18-inch walls.

The freight locomotives are each operated by a single electric motor, and are of low and compact construction. The third-rail system of operation is used, the rail consisting of a steel strip half an inch thick by four inches wide, clamped between insulated wood stringers laid lengthwise in the center of the track. This rail, besides furnishing the current, is provided with openings for the teeth of cogwheels, which are mounted on the underside of the engine, the rack and pinion system being used, and the wheels carrying only the weight.

The tunnels offer a speedy and convenient method of transporting the mails to and from the central postoffice, its many branches, and the various railroad depots. At present mails are carried almost entirely by wagon on the street surface. The company hopes eventually to secure the contract for this transportation, though as yet no definite arrangements have been made.

In the building of the tunnels, it was decided, after consultation with the city engineer, that the roof of no tunnel should be allowed to come closer than 24 feet 6 inches from the surface of the street. In this way, in the opinion of the city officials, sufficient space was left for the construction of a subway for the passage of street cars, if, in the future, such should become necessary.

Before beginning the actual excavation, a large amount of preliminary work was found necessary; and it was not until September, 1901, that the first gang of miners were started at a point in the alley between Madison and Monroe streets, immediately west of La Salle street. As rapidly as possible thereafter, seven other shafts were started, the basements of

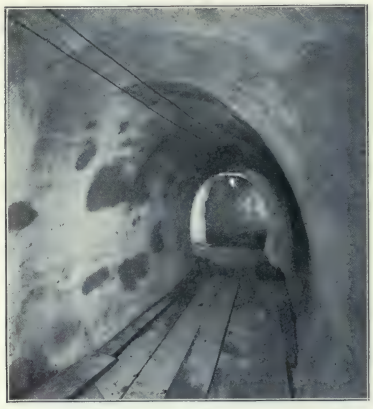


Shaft No. 3, Looking North.

buildings located at the points selected being leased for the purpose. The work of excavating was done by three shifts of men, working eight hours each. The first shift of miners went on at 4 o'clock in the afternoon, and worked until midnight; the second shift went on at midnight, and worked until 8 o'clock in the morning; the third shift, which was known as the "concreting" shift, went on at 8 in the morning, and worked until

they had completed the job before them, it being arranged that they should get through so that the miners could begin promptly at 4 o'clock in the afternoon.

A total of about 850 men were employed in the tunnel construction, about 600 additional men being employed in the office force, in the hauling of cement, gravel, and other materials, and in the carrying away of the excavated dirt. For the purpose of expeditiously getting the excavated dirt to the elevator houses, where it was lifted to the street level, 900 little tram cars were used. These tram



Tunnel at State and Lake Streets, Looking North.

cars were only four feet long and twenty inches wide, and Chief Engineer Jackson believes that largely because of the smallness of these cars there was no delay in getting the immense quantity of dirt out of the way of the concrete gang who followed so closely behind the miners.

The little cars, loaded with dirt, were lifted by elevators to the mouths of the elevator shafts, where they were dumped into waiting wagons, and then promptly sent back down the shafts for fresh loads. So perfect were all the arrangements and so rapidly was the work done, that in ten and a half months of actual work, no less than twelve miles of tunnel was completed, and that without any accident to workmen, or, on the testimony of Chief Engineer Jackson, a single complaint from a pedestrian or property owner.

Relief of Street Congestion

The down-town streets of Chicago are almost continually blocked by the wagons of teamsters who are carrying away the dirt excavated in constructing the basements and foundations of the great sky-scrapers and other large buildings which are always in process of construction at various points inside the loop. This congestion the company hopes to relieve by contracting to remove through its tunnels the excavated dirt and other debris where old buildings are torn down. That this plan is more than a mere theory, is shown by the fact that the company has recently signed contracts to do this work in the case of two large buildings now in course of erection in the down-town district.

It also hopes to be able to relieve the congestion still further by conveying to the site of new buildings all or most of the material necessary in their construction. How great a relief it would be to have new buildings go up on their own ground, with no blocking of sidewalks and streets by loading and unloading wagons, every citizen of Chicago knows without the telling.

These are some of the principal ways in which the company expects to make its large investment profitable, at the same time leaving the surface of the streets free for the use and transportation of the people. If this is as yet chiefly an unrealized dream, unanimous Chicago will hope to wake up one day to find that the dream has been largely fulfilled.

Electric Power

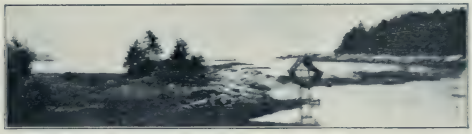
Power for the operation of the tunnel railroad will be furnished by a generating plant capable of producing 5,000 horsepower, for the construction of which the company is now about to let the contract. Direct current at 250 volts will be used, the rails acting as a return. Power for experimental purposes has been furnished by the Chicago Edison Company. The trains will attain a speed of between fifteen and twenty miles an hour.

The original purpose of building the tunnels as conduits for the cables and wires of the Illinois Telephone & Telegraph Company has not been lost sight of. These wires—now serving more than 5,000 subscribers—are carried along the

side walls of the tunnels, and there is plenty of space left for many times that number, the ultimate aim of the company being to supply at least 100,000 separate automatic telephone stations.

The company's plans include the extension of its present twenty miles of tunnels to nearly sixty miles, the territory to be tapped reaching from 71st street on the South Side, to Kedzie avenue on the West Side, and to Fullerton avenue on the North Side, the tunnels on the outskirts being reduced in size and adapted only to the carrying of telephone and other wires.

The chief interest, however, in the plans of the company, so far as the general public is concerned, lies in the present effort to relieve the congestion of the down-town streets by carrying freight and other commodities far down underneath the surface of the streets.



The Softening of Water for Steam-Raising Purposes

Essential Features and Comparative Values of the Continuous and Intermittent Systems

By WALTER H. GREEN

Secretary, Kennicott Water Softener Company

TO one who looks through the current engineering journals, it is unnecessary to say that there is at present a great deal of interest being displayed in the subject of water treatment. The railroad papers of the United States may especially be noted as giving more space to this than to any other one topic. The awakening of interest in this country is many years behind the appreciation of the question in Europe, where it has developed to a point sufficient to establish certain principles. It would be well for some of the many who are rushing into the business of water treatment in this country, if they would investigate the conditions of the problem somewhat carefully before investing their time and money in schemes that are predestined to fail—or, perhaps I should say, to fail *again*. In view of what has occurred in other fields, it is not surprising that all sorts of water-softening devices should now be thrust upon the market. The inventor—chronic and otherwise—sees the demand, and hears of the success others have made. The field is invitingly easy; all you have to do is to get the hard water into something, stir something into it, and the deed is done. The first water softener with which the writer had to do was built upon that principle, and it cost the company with which he was connected a good many thousand dollars to install the tanks, etc., and a couple of hundred to clear the ground of them about a year and a half later. There is now in operation at this plant a water softener which occupies a ground space fourteen feet by eleven feet, and which

TYPICAL WATER-SOFTENING PLANT INSTALLED FOR RAILROAD SERVICE.

does what was hoped to be accomplished with four other tanks covering 2,600 square feet of ground.

Practically all of the advance made in the United States has been made in the last six years; and, while this is not a very long time, it has been enough to advance the art beyond foreign practice in all points except the number of plants in operation. That this is true is evidenced by the failure on the part of practically all the softeners of foreign origin to succeed on this side in competition with the American product. In fact, only one company exploiting such foreign devices is at the present time showing much sign of life, and this one has not been very long in the field. A great many patents have been taken out in connection with water-softening apparatus within the past five years. Again, as in other lines, some of these are good and of real value; most are impracticable in themselves or because of competition; but altogether they so cover up the field that about all to be looked for now is in the way of minor improvements tending to produce more satisfactory or economical results.

It is not the intention in this article to consider the softening of water except for steam-raising purposes, although it is of value in many lines of industry. For instance, the writer knows of one laundry where a softener costing about $6,000 is saving $300 to $400 per month in the soap bill. At a woolen mill the amount of soap used in scouring has been reduced over fifty per cent and a considerable saving in dyes is made, while the goods are more satisfactory in color and feel.

Difficulties to be Overcome

Ever since steam has been raised for power purposes, and increasingly with the use of higher pressures, the use of natural waters has been accompanied with certain troubles, the more prominent of which have been scaling, corrosion, and foaming. Investigation has shown that scaling is caused chiefly by the salts of calcium and magnesium in solution in the water, and by silica, matter in suspension also contributing when present. Corrosion is caused by free acid in the feed water, this being common in mining districts; by salts of magnesium, which at boiling temperatures decompose with liberation of acid; and at times by organic matter. The use of condensed water, or water highly charged with oxygen, has also sometimes given rise to similar trouble. Different causes have been assigned for foaming, but in most cases it is due to soluble matter, such as salts of sodium and potassium,

Section of Water-Softening Tower.

concentrating in the boiler. Inasmuch as scaling is due chiefly to compounds of calcium and magnesium present in the water, practical softening consists largely in the removal of these. The salts of calcium and magnesium found in water are chiefly the bicarbonates, sulphates, and chlorides. Other compounds are occasionally present, but usually in very small amount; and treatment for those noted above will take care of all.

Softening Agents

It is not at all difficult to find substances which, when added to water containing these salts, will react with them to form new compounds so much less soluble in water that the greater part of the calcium and magnesium is thrown out in solid form. Experience has shown that of all such substances common lime and sodium carbonate are at once the best and cheapest; and these are what are used in practically all cases here and abroad.

The function of the lime is to remove the carbonates. Properly speaking, these should be called "bicarbonates," indicating an excess of carbonic acid present over what is necessary to form the normal carbonate. When lime is brought in contact with such bicarbonates, the excess of acid present combines with the lime, and the normal carbonate is produced. In this it should be noted that the added lime subtracts a part from the compound of lime (or magnesium) previously in the water, both portions subsequently existing in the same form as normal carbonates. These normal carbonates are soluble in water only to the extent of about three grains per gallon, and any excess formed above that amount deposits as a solid. It should be said here that, in addition to the amount of lime needed for the purpose indicated above, a further amount must be used, as in all natural waters there exists a greater or less amount of what is called free carbonic acid. This carbonic acid is simply in solution, not combined with anything; and lime to combine with it is needed before the other action can take place.

The carbonate of soda, commonly used in the form known as soda ash, reacts with the sulphates and chlorides. This action is not exactly like that of the lime, there being a transfer with the formation of two different substances instead of a simple subtraction. To illustrate: When sodium carbonate reacts with calcium sulphate, an interchange takes place in which are formed calcium carbonate and sodium sulphate. As all sodium salts are quite soluble in water, this sodium sulphate does not deposit and under certain circumstances must be considered.

Many attempts have been made, and some are still being made, to soften water containing small amounts of carbonate of lime and magnesia by the use of soda ash alone. A moment's consideration will disclose why these attempts fail. Soda ash brought into such water will form the carbonates from the sulphates, etc., present; but, instead of precipitating, these carbonates unite with the free carbonic acid spoken of above, and remain in solution as bicarbonates, with the net result that, instead of the water being softened, the total solids in the water have simply been increased by the amount of soda ash added.

WATER-SOFTENING PLANT.
One of the four systems erected for the Chicago, St. Paul, Minneapolis & Omaha Railway by the Tweeddale Water Softening Company, Chicago, Ill.

Experience having shown what are the best reagents for water softening, the questions that arise are: How much of these are needed, and how are they to be applied? The quantities to be used, of course, vary with different waters, and must be determined for each one by analysis. Lake Michigan water treated in a softener of the continuous type, requires about one pound of lime and one-third

pound of soda for every 1,000 gallons. This is a comparatively soft water, and many engineers do not think it pays to treat it; but at the factory where the above figures were obtained, a softener treating water for a battery of boilers of about 1,000 H. P. has resulted in economies that pay over 100 per cent yearly on the investment. At the other extreme, the writer knows of a softener on a railroad in the southwest where four pounds of lime and eight pounds of soda are used per 1,000 gallons.

The Modus Operandi

How these reagents are to be applied is a more complicated question, as there are many points to be kept in mind; and an attempt will be made to answer it by referring to what has been developed in practice. As preliminary to this, let us consider what it is necessary to accomplish. The water is to be handled through the softener to the point of consumption; on the way, there are to be mixed with it the requisite quantities of lime and soda; and the precipitate resulting from the action of these upon the impurities in the water is to be separated from the water and finally removed from the softening apparatus. The total process requires fine adjustment in the handling of considerable volumes and weights. When one reads from an analysis that a water contains, say, twenty-five grains of incrusting solids per gallon, this seems like a considerable amount; but when one stops to consider that a gallon contains 58,400 grains of water, and figures that the impurity to be operated upon amounts to but 0.04 per cent of the weight to be handled, the facts appear in a different light. In a softener of large size, the amounts of lime and soda to be handled in a day are nevertheless of no inconsiderable amount, and the sludge to be removed is of greater weight. A machine of 50,000 gallons per hour capacity, treating a 25-grain water and operating twenty hours per day, as is common on railroads, would use in the neighborhood of one and three-fourths tons of lime and soda daily. The solids precipitated to be removed would in dry form weigh about two and one-half tons, and at least double this amount in the wet form in which they must be handled.

Essentials of a Good Softener

In the selection of the best apparatus for the purpose, the main points usually to be considered are: Efficiency, economy of operation and maintenance, and first cost. These have been mentioned in what seems to the writer the order of their importance. Particular attention is called to this, not because it is unusual, but because the writer has in many cases seen even engineers of experience reverse their usual practice when it comes to water-treating apparatus, and consider only the first cost. This will certainly not continue to be the case after the differences between results become common knowledge, such as is had in other lines.

Intermittent and Continuous Systems

All the water softeners made until recently belonged naturally to one or the other of the two types known as "intermittent" and "continuous;" but lately there has appeared a third type, which, while essentially intermittent, adopts some of the features of the continuous, with results to be pointed out later.

The essential features of these types of softeners are indicated by their names. In the intermittent type the hard water is pumped into a tank; when the tank is full the reagents are mixed in, the sludge allowed to settle, and the clear water then pumped out. In some cases the tanks are elevated so that the clear water will flow to the point of use. The continuous softener, on the other hand, gives a steady stream of purified water equal to the amount of hard water being delivered to it, the mixing of the reagents and the clarification taking place as the water passes slowly through the apparatus. The outflow of purified water is at the top of the apparatus, thus avoiding the necessity of repumping.

The "continuously intermittent," as the writer once heard the hybrid variety called, is like the intermittent in that a tank is successively filled and emptied, but like the continuous in that the reagents are fed into the water as it enters the tank. In all cases that have come within the writer's knowledge, the water and reagents are again stirred together after the tank is full. Thus every part of construction and every step in operation of the intermittent type are present, the added complications serving to

increase the first cost and maintenance expenses, while not affecting the economy of operation or the efficiency except, it may be, adversely, by affording another chance for something to go wrong.

While in theory the only difference between the intermittent type and the continuous type is that which the name implies, in practice other things have developed, which will be discussed according as they affect the various points before referred to as necessary to be considered.

The items to be considered under the head of first cost are, of course, more than the bare amount to be paid to the manufacturer. The estimate should include everything that must be paid for to complete the plant ready for regular operation. Such items as foundation, housing, and piping will at once come to mind; and while these are all the extra items for a continuous softener, their cost varies widely for different makes. The most completely developed continuous softener, no matter of how large capacity, has but a single steel tank, and the foundation required is a simple circular pier, housing being required only about the top of the tank. Some continuous machines have two or more tanks, thus requiring several foundations, and as these tanks are connected by piping, etc., it is necessary to enclose the whole apparatus to prevent stoppage from freezing, etc.

In addition to the above-mentioned items, an intermittent plant will have charged against it one or more of many others. When the supply is by gravity or municipal service, a pump must be installed to rehandle the water, a boiler being thus required in isolated plants. This may be avoided by elevating the tanks, which will increase the cost for foundation, housing, and piping. Plants drawing their own supply will require two pumps, or one of double capacity, two pumps being necessary when one must be a deep-well pump. Elevating the tanks will have the same effect as noted before, and it should be observed that the bottom of these tanks must be elevated above the point of delivery, which is impracticable in railroad work. The value, present and prospective, of the ground covered should be included. How far-reaching the extra cost may become, was recently brought very forcibly to the writer's mind when visiting an intermittent plant in a Western State. The supply was from a well, and had always been sufficient until the softener was installed. When the attempt was made, however, to run the pump twice as fast as had been customary—which became necessary on account of the rehandling—it was found that the water could not be obtained, the maximum flow of the well being only slightly greater than the previous rate of pumping. In the case of the plant referred to, it will be necessary to put down another well and install another pump, and also to provide another boiler, as the present boiler is too small. The new well, moreover, must be located some distance away from the old one, thus involving the erection of a new pump-house.

SOVEREIGN OF THE SEAS.
British Line of Battle Ship Built in 1637. From an original picture by Vandevelde.

The Development of the Modern Battleship

A Review of Progress in Naval Construction during the Past Forty Years

No. III.—Recent Designs, and Details of Construction

By WALTER S. LELAND, S. B.
Instructor in Naval Architecture, Massachusetts Institute of Technology

IN THE TWO PRECEDING ARTICLES we have traced the development of the modern battleship from its origin in 1859 to the present time; we have considered the progress made in gun construction, armor, powder, and projectiles, and are now prepared to consider the essential features of the most recent designs, as well as some of the most important difficulties that present themselves to the naval constructor. Speed, coal endurance, offensive power, and armor protection, are all desirable; but it is usually the case that one or more of these essentials must be developed at the expense of the others, unless, indeed, there be no limitation to the size of ships.

Factors to be Considered

The naval constructor must thoroughly understand naval tactics, naval strategy, the possibilities of the ram, the danger of torpedoes, and the use of submarine mines. The dangers of coastwise navigation must be understood, and the strength of fortifications carefully weighed; for it is evident to a thoughtful mind that a battleship must be designed to meet special requirements, just as a merchant ship must be, and it is quite possible that a battleship suitable for the United States

Illustrations by courtesy of *Scientific American*, *Cassier's Magazine*, and *Collier's Weekly*.

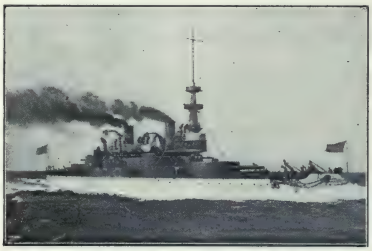
would not be adapted for English or German service. The extent of a nation's coast line, the volume and importance of its sea-borne commerce, the extent of its colonial possessions, and its political aspirations, are all dominant factors in determining the most suitable type of battleship.

VICTORY.

Lord Nelson's Flagship at the Battle of Trafalgar, on which he died.

Gun Fire

The most essential feature of the modern battleship is undoubtedly the gun fire.



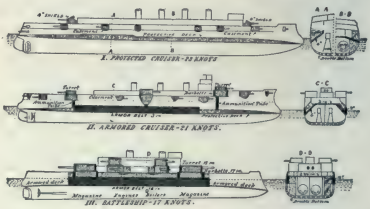
U. S. Battleship "Indiana."

Twin Screws. Displacement, 10,231 tons. Indicated Horsepower, 9,000. Speed, 16 knots. Built at the Cramp Yards, Philadelphia, Pa.

Concentrated gun fire is essentially the keynote of successful fleet action, and demands not only a proper installation of guns, but a corps of well-trained officers and men. The guns must be of sufficient power to engage the probable adversary, and the fire must be both rapid and accurate. It is considered the best move in naval warfare to assume the offensive; and it is the precision and accuracy with which the first few shots are fired that will usually decide the battle. It has been said that the best protection against the enemy's projectiles is a well-directed fire from one's own guns; and this is unquestionably of the greatest importance.

Coal Supply

Perhaps the next feature of most importance is a proper coal supply. Our own vessels that may be required to go a long distance and then be ready for action, must necessarily have large coal-bunker capacity. A German battleship,



Comparative Armor Protection in Principal Types of Modern War Vessels.

on the other hand, belonging to a nation with comparatively few important colonial dependencies, and having naturally a compact seacoast abounding in natural protective features, is not likely to be called upon to engage in battle after a long sea journey. Coaling stations are

THE ARMORED FORT WITHIN THE OUTER WALLS OF A MODERN BATTLESHIP.
All parts above the water line, shown by dotted lines and light shading, might be shot away without destroying the fighting power of the ship.

near at hand, and it is folly to build vessels with immense coal capacity.

Let us compare for a moment this one feature of the leading battleships of the two navies. In the latest designs of our own country, we find vessels carrying 1,700 tons of coal and upward, while the German ships usually have 1,000 tons or less.

It is by no means economical to carry a larger coal supply than is really essential; and the same is true of armor and ammunition. To make this point clear, let us consider two vessels armed with the same type of guns and having the same powered engines. One will have

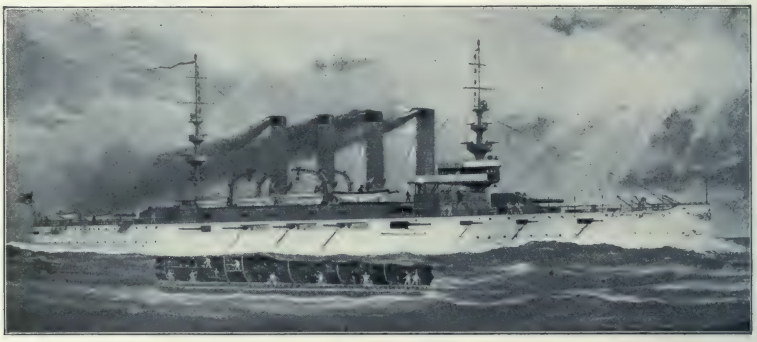
FORWARD DECK OF U. S. S. "MASSACHUSETTS."

1,000 tons more coal than the other, and 600 tons more armor. This will require a much larger vessel, and the displacement must be increased enough to sustain not only this added 1,600 tons, but also the extra weight due to an increased size of hull. This item is likely to be as much as 400 tons, so that the difference in displacements will be about 2,000 tons. If the engine power is to remain the same the speed will necessarily be reduced.

U. S. S. *MASSACHUSETTS.*
Twin-screw Battleship. Displacement, 10,231 tons. Indicated Horse-power, 9,000. Speed, 16 knots.
Built at the Cramp Yards, Philadelphia, Pa.

Speed

In time of action, speed is an all-important factor. The ability to attack an enemy at an advantageous time, to keep him in a desired position, and to withdraw from action if necessary, are features of the greatest importance, and demand speed and manœuvering power. The smaller ships will have not only greater speed with the same engine power, but greater manœuvering ability.

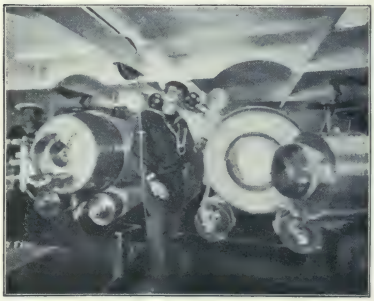


U. S. S. *CALIFORNIA.*

Armored Cruiser. To same class belong the *Colorado, Maryland, Pennsylvania, South Dakota,* and *West Virginia.* Displacement, 13,680 tons. Speed, 22 knots. Bunker Capacity, 2,000 tons. Armor: Belt, 6 in. to 3½ in.; turrets, 6½ in. to 6 in.; barbettes, 6 in.; deck, 1½ in. to 4 in. Armament: 4 8-in., 45-caliber B. L.; 14 6-in. 50-caliber R. F.; 18 3-in. R. F.; 12 3-pdrs.; 8 1-pdrs.; 2 3-in. field guns; 2 machine guns; 6 automatic guns. Torpedo tubes, 2. Complement, 822.

Armor Protection

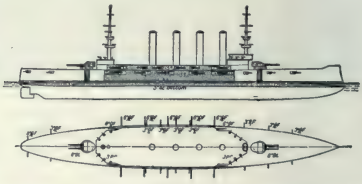
Armor protection cannot of course be overlooked; and, indeed, it is a very difficult matter to say which of the four main essentials deserves the greatest consideration, for a failure in any one of them may mean the destruction of the ship. The conditions of actual service will in every case determine the relative importance of guns, coal, speed, and armor, that is, as far as the judgment of the designer is concerned.



INTERIOR OF TURRET ON BOARD U. S. S. "MASSACHUSETTS."

It must further be borne in mind that increase in size not only adds to the cost of construction, but offers a larger target to the enemy; and yet the above-mentioned essentials can be combined in a maximum degree only on a ship of great size and power. To keep the ship from being too large, some sacrifice must be made.

After all has been said on all sides, by those who advocate extreme speed, and by those who favor extreme protection, there is one well-acknowledged fact to fall back upon; and that is, that the naval engagements of modern times have not



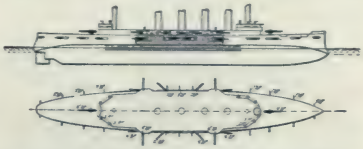
ARMOR AND GUN PLANS OF THE "CALIFORNIA" CLASS OF ARMORED CRUISERS.

been conclusive, for, where the ships have been of equal power, there has been a great difference in the ability and efficiency of the opposing crews, and, after all, it is "the man behind the gun" that hits the mark. 'Tis he that wins or loses the battle.

Distribution of Weight

The layman in looking about a battleship is ever impressed with those features that to the constructor are of least importance. He wonders at the size of guns, the massiveness of the turrets, the thickness of armor, and the like. To him, ponderosity is the chief essential, while the designer, on the other hand, labors to make everything as small and compact as possible, reduces weight in every possible instance, and worries his brains in determining the proper location of all of these massive weights. Anyone would see at a glance that if all these weights were located near the bow, the ship would go down "by the head;" and if they were all located aft, she would trim badly "by the stern;" but who is there, not trained to the work, who ever thinks of what a tremendous problem it is, so to locate the engines, turrets, coal, magazines, and stores, that the ship will lie on an even keel, not only when full and ready for sea, but at all times thereafter when the bunkers are nearly empty and the provisions consumed?

Everyone knows that if the designer should put massive weights at the masthead, the ship would be unstable and likely to capsize; but who would ever think that those same weights might be placed too low? If the center of gravity of the ship be too low, she will roll with a quick, snappy motion likely to loosen



ARMOR AND GUN PLANS OF THE SEMI-ARMORED CRUISERS "ST. LOUIS," "CHARLESTON," AND "MILWAUKEE."

the turrets and set them swinging; or she might strain the masts and perhaps break loose her boats and gear. Who but the naval architect realizes the delicate problem of so locating the weights that the vessel will slowly and steadily, yet always, return erect? Should it so happen that the location of heavy weights could not be altered sufficiently to produce the desired stability, then the form of underwater body must be modified to suit the existing conditions.

U. S. S. *ST. LOUIS.*

Semi-Armored Cruiser. To same class belong the *Charleston* and *Milwaukee*. Displacement, 9,500 tons. Speed, 22 knots. Bunker Capacity, 1,500 tons. Armor: Belt, 4 in.; Topsides, 4 in.; Deck, flat, 2 in.; slopes, 3 in. Armament: 14 6-in. R. F.; 18 3-in. R. F.; 12 3-pdr. semi-automatic, 4 1-pdr. automatic, 2 3-in. field guns; 2 .30-caliber machine guns; 8 .30-caliber automatics. Complement, 564.

Ease of Construction, and Cost

Among the desirable features of a lesser magnitude may be mentioned ease and rapidity of construction, together with economy of cost. Of late years the tendency has been developed, to use only a few standard "shapes" in the construction of our battleships, which enables the rolling mills to turn out material in much

less time than heretofore. Moreover, all fittings about the ship are standardized, thus greatly reducing the cost of drafting and pattern making. Care, however, is

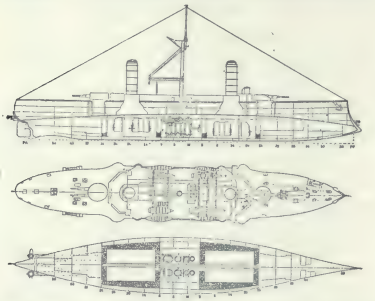
Japanese Protected Cruiser "Nisshin."

taken that parts open to improvement are not standardized.

In building naval vessels, the item of cost plays only a minor part. This indeed should be so; but too often the cost item entirely escapes attention. The cost of naval vessels compared with merchant ships is necessarily high, owing to the fact that the more expensive forms of construction have frequently to be adopted in order to save weight. Various fittings are for the same reason made out of composition instead of iron. The numerous water-tight subdivisions add materially to the cost, and the work is done in a more thorough and workmanlike manner.

Subdivision of Hold Space

The hold spaces on a warship are minutely subdivided into compartments



Elevation and Deck Plans of the Japanese Protected Cruisers "Nisshin" and "Kasuga."

for special purposes. These compartments are separated by bulkheads running fore and aft and athwartships, and by decks and parted decks, all of which add greatly to the general strength and stiffness of the vessel. This permits the use of lighter framing, still maintaining a proper degree of strength. This minute subdivision of the ship's hold adds materially to the vessel's safety, for, should the side of the ship be ruptured, water could pour into only one or two comparatively small spaces, while a merchant ship having holds seventy feet and more in length would almost instantly sink.

The armor is simply a dead weight without any structural strength whatever, except what is derived from the framing that supports the armor. If it were possible to fasten these armor plates to each other, as well as to the backing, they would serve the double purpose of strength and protection.

British Battleship "Ramillies."

Twin Screws. Displacement, 14,150 tons. Indicated Horsepower, 13,000. Speed, 17½ knots.

The gun ports on the main deck frequently cut the plating away so as to weaken the ship at that point. To compensate for that, a double thickness of plating is used in adjacent places, and the side plating of the ship may be doubled to protect against the blast of the guns when firing.

A battleship is so complicated and so cut up that the naval constructor's problem to provide sufficient strength is by no means an easy one, especially since the framing has to be as light as possible in order to save weight. In the construction of a battleship there are two features that must be preserved at all cost—namely, lightness of construction, combined with Strength and Rigidity.

Use of Wood Avoided

The use of wood in naval work is avoided as far as possible. The stateroom partitions and all interior arrangements are built of sheet-steel bulkheads stiffened with light angle irons. The furniture, of course, has to be of wood; likewise the deck planks; but every piece of wood that enters a battleship of to-day has been put through a fireproofing process. This wood will burn if put in a fire; but it is not inflammable, burns very slowly, and usually will simply char. The disastrous effects of non-fireproofed wood were clearly shown in the destruction of the Spanish fleet off Santiago, where by far the greater portion of the damage was caused by fire.

Ventilation

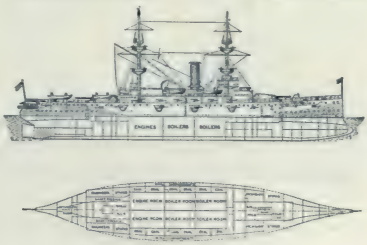
The minute subdivision of the vessel's hold prevents the free circulation of air, and necessitates some method of artificial ventilation. The most usual practice is to force fresh air into the compartments through numerous ducts, and let it escape as best it can. To lessen danger from the spontaneous combustion of coal, the bunkers must be thoroughly ventilated. A proper arrangement of cowls will usually give a sufficient air supply to the fire room and engine room, and an open casing around the smokestack will help to carry off the heated air from the fire room, while the engine-room skylights will serve a similar purpose in the engine room. If forced draft is used, separate fans must be provided for the purpose.

U. S. S. *DENVER.*

Semi-Protected Cruiser. To same class belong the *Cleveland, Chattanooga, DesMoines, Galveston,* and *Tacoma.* Displacement, 3,200 tons. Speed, 16¼ knots. Bunker Capacity, 700 tons. Armor: Deck, ½ in. flat; 1 in. to 2 in. slopes. Armament: 10 5-in. R. F.; 8 6-pdrs.; 2 1-pdrs.; 4 Colts; 1 3-in. field gun. Complement, 293.

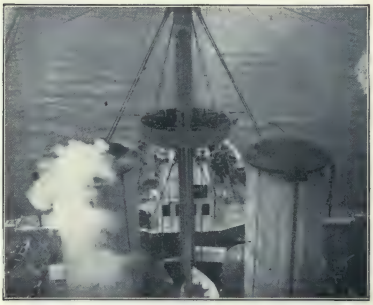
Armor Belts and Protective Deck

The distribution of armor is always a vexatious problem. First of all, a heavy belt must extend around the vessel to protect the sides at the water line, the most vital point that affects the stability of a ship. This belt must be seven or



A Modern Battleship Design.

eight feet wide, extending from about 3½ feet below the water line to 4 or 4½ feet above. The top of this belt amidships may be in the vicinity of 12 inches



FIGHTING TOP OF BRITISH BATTLESHIP "ROYAL SOVEREIGN."

thick, while the bottom may be 9 inches, the whole belt tapering in thickness forward and abaft the machinery space to about 4 inches at the extreme ends. A protective deck, flat in the middle and sloping at the sides, is laid over the machinery space, forward and abaft of which it slopes downward. This deck consists of two or three courses of plating, the top course heavier than the rest, and may be in the vicinity of 2 inches thick where flat, and 3 inches or more on

BRITISH TURRET BATTLESHIP "TRAFALGAR."
Twin Screws. Displacement, 11,940 tons. Indicated Horsepower, 12,000. Speed, 16¾ knots.

the slopes; this affords an excellent protection for the vitals of the ship.

The main armor-belt usually rises a little above the level of the protective deck flat; and above this rises what is known as the "casemate" armor to a height of perhaps 16 feet. This casemate armor covers the vessel's sides for about half the length amidships, then extends across the protective deck to the barbettes which support the turret, thus forming an entire enclosure with about 6-inch protection. The casemate armor usually extends to the upper deck, and affords a suitable protection for the rapid-fire guns. On the gun deck, numerous "splinter" bulkheads are constructed between the guns, to prevent splinters from flying about the deck space and injuring the men.

Barbettes

The barbettes are usually built of 10-inch or 12-inch armor, and are circular in cross-section. They surround the ammunition-handling room and protect the tur-

BRITISH BATTLESHIP "RESOLUTION."
Twin Screws. Displacement, 14,150 tons. Indicated Horsepower, 9,000. Speed, 16 knots.

ret-turning machinery. They form the support on which the turret turns.

Turrets

The turrets for 12-inch guns are built of about 12-inch armor on the sides, and thin armor on top; while for the 8-inch gun turrets, armor of about 6 or 7 inches in thickness is used.

The turrets contain guns mounted in pairs so that the muzzles can be raised or lowered, and, as the turret turns, the guns can be pointed in any direction that does not bring them in range of the deck house and superstructure.

Magazines

Below the protective deck, at the very bottom of the hold, the magazines are usually placed, and are all fitted with flooding valves, which can be operated

from the main deck. Should an accident occur whereby the powder in the magazine might be exploded, these valves could be instantly opened, and a deluge of seawater admitted to that particular compartment likely to give trouble. The effective water tightness of adjacent doors and bulkheads would prevent this water from wetting the material in other compartments.

Ammunition hoists convey the ammunition to the turrets, and to the gun decks, these hoists being protected above the protective deck by armored tubes.

Torpedoes

The torpedo is an important adjunct of modern warfare, and many of the most recent battleships are equipped with torpedo tubes discharging under water. Above-water tubes are no longer used by any important navies. The maximum range of the torpedo is in the vicinity of 2 miles, and it is reported that the Japanese are using them effectively at ranges of a mile or more.

Marine Engines

The available machinery space in a battleship demands an engine very different from that used for a merchant ship.

German Battleship "Woerth."
Twin Screws. Displacement, 9,842 tons. Indicated Horsepower, 9,500. Speed, 16 knots.

The engine space is necessarily small, the power high, and the machinery must all be placed below the protective deck, which necessitates a shorter stroke and more revolutions. The higher power is obtained in the smaller space by increasing the steam pressure. This high speed of revolutions naturally tends to heat the bearings; consequently an elaborate system of oil pipes has to be provided, and a large number of pipes are necessary to carry cooling water to the most important bearings, all of which gives a naval engine an exceedingly complicated appearance.

In twin-screw vessels, two engines have sometimes been connected to each

Italian Battleship "Sardegna."
Twin Screws. Displacement, 13,860 tons. Indicated Horsepower, 22,800. Speed, 19 knots.

shaft, the forward one being disconnected while cruising. This has proved a very economical method; but it is impossible to couple on the forward engine quickly should there come a sudden demand for speed.

The demand for high-pressure steam has naturally led to the adoption of water-tube boilers. This type of boiler still has its enemies, but is nevertheless fast gaining favor in this country and abroad.

Auxiliaries

The number of auxiliary engines on board a modern battleship is enough to startle a man not familiar with the work; but large as it is to-day, it is less than it was a few years ago, owing to the introduction of electricity for many purposes. This of course requires a motor instead of an engine, but the wiring for electricity is less bothersome than the intricate piping necessary where steam is used. The turrets, ammunition hoists, boat cranes, and winches, are now usually operated by electricity instead of by steam or hydraulic machinery.

A tremendous amount of steam is used for distilling fresh water from the sea, and for the refrigerating plant. In the *Louisiana*, now building, provision is made for the evaporation of 16,500 gallons of water, the distillation of 10,000

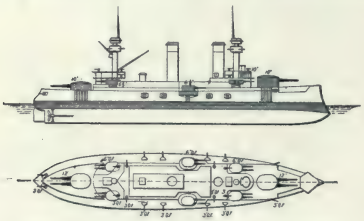
The following table, giving statistics of typical vessels of various navies, will be found useful for comparison:

Typical War Vessels

Country	United States	Great Britain	Japan	Russia	France
Name	*Louisiana* and Class	*King Edward VII.* and Class	*Mikasa*	*Czarevitch*	*R'publique* and Class
Displacement	16,000 tons	16,350 tons	15,200 tons	13,000 tons	14,865 tons
Speed (Knots)	18.0	18.5	18.6	18.0	18.0
Coal (Normal)	900 tons	950	700	....	900
Coal (Maximum)	2,200	2,000	1,500	1,250	1,850
Armament:					
Main Battery	4—12-in. 8— 8-in. 12— 7-in.	4—12-in. 4— 9-2-in. 10— 6-in.	4—12-in. 14— 6-in.	4—12.4-in. 12— 6-in.	4—12-in. 18— 6.4-in.
Secondary Bat'ry	12— 3-in. 12— 3-pdrs. 14 Machine	14— 3-in. 14— 3-pdrs. 2 Pom-poms	20— 3-in. 6— 3-pdrs. 6—2½-pdrs.	20 — 3-in. 20— 3-pdrs. 8— 1-pdrs.	26—3 pdrs. 2—1 pdrs.
Torpedo Tubes	None	4 Submerged	4 Submerged	2above, 2below	3 above, 2 below
Protection:					
Water-line belt	11 in. amid. to 4 in. ends.	9 in. amid. to 2 in. ends	9 in. amid. to 4 in. ends	10 in. amid. to 2½ in. ends	11 in. amid. to 6 in. ends
Casemates	7 in. to 6-in.	8 in. to 5 in.	6 in. throu'out	6 in. to 2½ in.	10 in. to 3 in.
Bulkheads	7 in. sloping for'd, 7 in. aft	12 in. fore & aft	14 in. fore & aft	None	None
Heavy gun turrets and barbettes	12 in. to 7½ in.	12 in. to 8 in.	14 in. to 8 in.	11 in. to 10 in.	11 in.
Smaller gun turrets & barbettes	6½ in. to 4 in.	7 in.	No small gun turrets	7 in. to 5 in.	6 in. to 5 in.
Protective deck	3 in. to 1½ in.	2 in.	4 in.	4 in. to 2 in.	4 in. to 2 in.
Weight of Armor	3,992 tons	.....	4,600 tons	4,000 tons	.....
Length, Beam, and Draft (feet)	450x76¾x26¾	425x78x26¾	436x76x27¼	387x75½x26	439½x79½x27½
Indicated Horse-Power	16,500	18,000	16,400	16,300	17,500
Boilers	12 Lab. & Wil.	Bab. & Wil. with Scotch	25 Belleville	20 Belleville	.....
Crew	803	800	730	700	822

NOTE:—Japan and Russia follow the systems of armoring adopted by England and France respectively. The former armor almost the entire side, and mount the greater part of their secondary guns in a broadside casemate battery. The latter use no side armor except the water-line belt, and distribute their secondary guns in pairs in turrets, with armored barbettes or ammunition hoists.

gallons of water, and the manufacture of 3 tons of ice, every twenty-four hours.



Armor and Gun Plans of Russian Battleship "Czarevitch."

Provision for Repairs

It would never do for so complicated a piece of mechanism as a battleship to go to sea without proper means for making repairs. With this end in view, the *Louisiana* is provided with a machine shop containing two lathes, a column-shaping machine, a back-geared vertical drill press, a sensitive drill, a universal milling machine, a combined punch and shears, an emery grinder, and a common grindstone. A large supply of spare parts and rough material is carried in the engineer's storeroom so that all minor repairs can be attended to by the ship's own crew.

The *Louisiana* is one of our finest battleships, and is now building at Newport News, Va. The contract called for completion in 42 months, and the complete cost will be $7,500,000, including armor, guns, and equipment.

The steering engine and the windlass are the only engines outside the engine-room that use steam, all else being run by electric motors. The vessel is to be lighted throughout by electricity, and a complete telephone system will be installed.

RUSSIAN BATTLESHIP "CZAREVITCH."
Sunk by Japanese Torpedo at Port Arthur. Displacement, 13,000 tons. Speed, 18 knots.

The largest battleship in the commission of any navy in the world is the *Mikasa,* flagship of the Japanese fleet off Port Arthur. She is 800 tons less in displacement than our *Louisiana* class, and has a somewhat better speed, but carries a lighter armament and smaller coal supply.

FRENCH BATTLESHIP "MARCEAU."
Twin Screws. Displacement, 10,581 tons. Indicated Horse-power, 12,000. Speed, 16¼ knots.

The Italians have produced an exceedingly interesting vessel, the *Vittorio Emanuel.* It has only two 12-inch guns, but otherwise the armament corresponds fairly well with that of other similar vessels. The weight saved in having only two heavy guns, is in this case devoted to speed. These vessels are similar in many ways to armored cruisers, having a speed of 22 knots, but are more powerfully armed and have better protection.

JAPANESE BATTLESHIP "MIKASA."
Largest Battleship Afloat. Flagship of Admiral Togo's Fleet off Port Arthur.

The prospect is that this type of boat will displace the ordinary armored cruiser.

The most noteworthy new English battleship gives its name to the *King Edward VII.* class. She closely resembles the *Mikasa,* although of rather greater

RUSSIAN BATTLESHIP "NICOLAI I."
Twin Screws. Displacement, 8,440 tons. Indicated Horse-power, 8,000. Speed, 14¾ knots.

displacement. Like the *Louisiana,* her turrets, hoists, and deck machinery are operated by electric motors.

The Technical World

Published Monthly by the

American School of Correspondence

at

Armour Institute of Technology

Chicago, Ill., U. S. A.

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SUBSCRIPTIONS

United States, Canada, and Mexico $2 per year
Foreign Countries . . . . . $3 per year

¶Remit by Draft on Chicago, Express or Postoffice Money Order, payable to The Technical World.

¶Entered at the Postoffice, Chicago, Illinois, as second-class mail matter.

40,000 Copies this Issue Printed and Mailed

Advertising Rates on Application

¶Copy for Advertisements must be received by the 1st of the month.

The man of grit generally has lots of sand.

When the outlook is not good, try the uplook.

An agreeable person is one who agrees with you.

Tact does not remove difficulties but goes around them.

The man who was stoned to death was rocked to sleep.

A self-satisfied man is seldom satisfied with anyone but himself.

The true secret of success in life is to know what you can't do well.

People carried away with enthusiasm are often brought back in disgust.

There is a profound distinction between the masculine and the manly.

Some men are so awed by the dignity of labor that they keep a respectful distance from it.

It is not so much what man has that makes him happy, as it is what he doesn't want.

Most of us would be troubled with indigestion if we were forced to eat our own words.

Many people become unpopular because they do not take sufficient pains to conceal what they know.

A man may be the architect of his own fortune, but he cannot induce the sun to shine in every room.

When money is lost, nothing's lost. When health is lost, something's lost. When character is lost, all is lost.

There is so much that is bad in the best of us, and so much that is good in the worst of us, that it doesn't behoove any of us to be careless in talking about the rest of us.

The World's Work for the World's Pay

A FAITHFUL RAILROAD BRIDGE-BUILDER, asked whether the plans and specifications for rebuilding a burned bridge had been given him, replied: "The bridge is done, and trains has been runnin' over it since daylight, but I haven't seen nothing of the picture yet."

Without offense to our brethren who make the plans or "pictures," due honor may be paid to the man who builds the bridges. A large part of the world's people gives its readiest welcome to the man who does the materialistic thing, condemning often with faintest praise the man who only tells how. Perhaps it is well that this is so, for the making of the plan has in it something of creative joy which helps to pay the price, while handling steel beams in freezing rain is grimmest play at best. It seems unlikely that we shall come soon again to combine the artist and the artisan in the same person, so that one man, with a notion born clear as crystal, in darkness and in silence, may perfect the scheme and build the thing. Men did so once, and so they may again; just now, however, most execution is on lines laid down by others than the hand-workers. Let us be glad the craftsman gets his share of recognition.

The Dead Line in Industry

HOW OLD ARE YOU? If you are fifty, according to the newspaper philosopher, you have crossed the dead line. It is true the nervous strain of modern life uses men up early; yet this is probably not so much the effect of work as the result of the reserve forces of our vitality being sapped in earlier years by late hours, by stimulants, by the excessive use of tobacco, and the like.

The recent action of several corporations in discharging men over a certain age, who had not been promoted during their connection with their firms, has nothing to do with gray hairs. It was simply a matter of the men not "making good." This action by these companies is a warning to young men that they must prove their worth in young manhood, that the dead line in industry is reached when a firm finds out that a man, after a certain term of service, has shown no special ability, no special skill worthy of promotion.

Ambidexterity

FOR MANY YEARS the left-handed man has been the "under dog." In the discussion of ambidexterity by experts, it has been used against him, that left-handedness is associated with defective moral character; that the moral man is not only right-handed, but, if we may be pardoned for the expression, "right-legged" and "right-eyed," using these organs in preference to the left.

We notice that a society has been formed in England to encourage ambidextral culture. According to the report of its Secretary, the lines along which the society intends to work are: First: That it is possible to do two things well; and that every intelligent person is capable of becoming an expert in the performance of two concurrent and unrelated acts, just as he may be in the separate accomplishment of each. Second: That it is both proper and advantageous to prepare and qualify children for the exercise of two-handed work, and more especially of two-handed writing, during school life.

There is no legitimate reason why the left hand should not be trained to a greater use than it is at present. From our point of view, when compelled to drive a nail in certain kinds of corners, we can bear witness that our ambidexterity has made unnecessary the use of a vast number of picturesque adjectives, which no amount of right-leggedness or right-eyedness would have been capable of keeping back.

A Wanton Waste

THE "STAR EVENT" of the recent convention of the National Association of Piano Makers, was, according to the daily papers, the burning of a pile of over one thousand square pianos on the beach at Atlantic City, N. J.

This may have been a shrewd business move on the part of the piano dealers, to signalize the passing into history of the time-honored square piano, and incidentally to get rid of the nuisance of handling such pianos in exchange. Ethically, however, such wanton destruction of property is all wrong, and cannot under the circumstances be justified in the name of business expediency. This is particularly true in the present case, as the officials of the Association, according to reports, were the recipients of many letters not only from charitable organizations, but from individuals, begging them not to permit a waste of property that might give pleasure to so many families.

The action was that of immature school boys rather than of sane business men.

The Ideal Foreman

MR. TURNER'S article under this title should interest the man who is, or who hopes to be, a foreman, as well as the employer of foremen. The topic is a live one, especially in this day of strained relations between capital and labor, between employers and employees. Ideas differ widely on the qualities of mind and temperament that the ideal foreman should possess, as well as on the matter of his duties to his employer, to his men, and to himself. Let us have discussion on this subject. While an old problem, it assumes new phases in view of changing conditions.

Reform the Fourth

IS THERE NO WAY to restrain the fool-killer? Four thousand four hundred and thirty-four killed and wounded, is what last year's celebration of the "Glorious Fourth" cost the United States in human life. If some steps are not taken to put a stop to this reckless waste of life, a few more years may run up a list of killed and wounded that will outnumber the losses of the colonies in the battles of the Revolution.

It is high time that the parents of the nation demand that the signing of the Declaration of Independence be commemorated in some safe and sane manner. We have no desire to throw cold water on the pleasures of our young people; but we sincerely believe that the time is ripe to arouse public sentiment against the promiscuous fashion in which dangerous explosives are sold and used by children and by certain "fool" grown people.

Practical Patriotism

NO MATTER on which side of the present Japanese-Russian war one's sympathies may lie, all must admire the Jap's courage, spunk, grit, "ginger," patriotism, or whatever other quality of mind it is, which, combined with his wiry little body, makes him accomplish the deeds of valor that he does.

We like to feel that every true American will die for his country *if need be.* Such is our idea of patriotism. The Japanese, according to reports, carries the idea one step further. He prefers death to surrender in any circumstances. The officer who killed himself on the deck of a sinking Japanese warship takes front rank in point of patriotism, according to the Japanese idea. This idea makes great fighters, but the Editors of THE TECHNICAL WORLD do not stand alone in the belief that a little of the "He who fights and runs away may live to fight another day" doctrine, in no wise spoils the value of a true fighter.

There is no lack of patriotism in a man who braves a galling fire, and steers right into the mouth of danger to accomplish a valuable result for his country, and who, having done the deed, turns and runs. He may then live to do another.

This adds a little practical flavor to patriotism which seems to suit the American mind. It cannot be denied, however, that an army of patriots who prefer to die rather than to show even temporary weakness is a hard proposition for the other side.

The Mosely Commission

SINCE RETURNING to England the members of the Mosely Commission have been engaged on a report that would place before our cousins across the water the condition of education in the United States. With the exception of three members, all the commissioners have submitted individual reports which deal with the different phases of our educational system.

The *London Times,* discussing the report of the Commission, draws the following conclusion:

"That there is yet nothing like finality in American educational institutions, any more than in our own. They, like us, are feeling their way along more or less untried ground; with greater energy, perhaps, and more freedom of experiment, as differences in national character and outlook, or the absence of old traditions, class distinctions, and religious difficulties, have smoothed the path of reform. The educational awakening that is beginning here has come earlier in them, and is being followed up more quickly."

Technical Value of the World's Fair

Exhibits of the Varied Achievements in Science Furnish Instruction as well as Entertainment.—Every Branch of Industrial Study is Represented by Practical Demonstrations of Experts

By JOHN C. SMALL

IN THE STRONG LIGHT of great industrial expositions like the World's Fair which is to be in progress at St. Louis during a greater part of the year, unwieldy thoughts of the student are brought together in comprehensive realizations of the great truths of science; and the haze of technicalities which baffles the earnest mind, is dissipated by practical demonstrations.

Geniuses of the world bring their achievements forth at this time for an exchange of ideas, much as boys and girls in their school days oftentimes proudly display the solutions of examples worked out on their slates from problems submitted by the critical schoolmaster. Then it is that knowledge seems less evasive, and the understanding more agile.

Instead of the World's Fair at St. Louis being a gathering of school children, however, it is the greatest congress of noted scientists that has ever assembled in the world's history. There is no branch of endeavor but is represented at the Exposition, both by its most worthy champions and by the examples of their deeds.

The newest of everything that man has achieved is shown, even to radium, wireless telegraphy, liquid air, and the airship. Pieces of mechanism, and solutions of chemistry, are there to suggest to the fresh mind of the student the possibilities for further research. In truth there is no aid to the pupil like these periodical expositions, which have been called the "milestones of civilization."

Study of Light Making

Every stage in the evolution of light-making, from the primitive candle to the modern vapor air lamp, whether the source of illumination be oil, gas, or electricity, is interestingly illustrated at the World's Fair.

Thomas A. Edison, Chief Consulting Engineer of the Department of Electricity, has a personal exhibit showing the earlier forms of the incandescent lamp. How it grew from a crude fancy to the perfected light, is demonstrated by the inventor.

In the last ten years, inventions in the line of electric lighting have been numerous, and a display of these ingenious appliances is a chief feature of the electric exhibits. Arc lamps of every kind are shown, and incandescent lights of every color and size exhibited. Nernst lamps will be used in lighting one of the buildings, and the Cooper Hewitt mercury vapor lamps will be exhibited. These vapor lamps emit an intense white light in which the absence of red rays gives to the glow the peculiar effect that will make of the Cascades the chief decorative feature of the Exposition. Vacuum-tube lighting by means of induced currents is also fully demonstrated.

Lighting and its accessories are treated in three different departments. Everything that is electric in its character is shown in the Palace of Electricity; light produced from petroleum oils and from natural gas will be a part of the mineral exhibit in the Department of Mines and Metallurgy; and light produced by manufactured gas and chemicals, and all the various appliances for producing and diffusing light, from whatever source, will be displayed in the Palace of Manufactures.

Monster Exhibits of Machinery

The Machinery section of the Louisiana Purchase Exposition is unique in that the Exposition's mammoth power plant, which operates all the machinery in the Exposition, is itself an exhibit. This plant has a capacity of 45,000 horsepower. It is one of the largest power plants in existence.

The power plant consists, first, of the boiler battery; second, of the steam engines in which the steam produces motion; and third, of the electric generators by which the motion of the steam engine is converted into electrical energy. The transmission of power between buildings is in the form of electricity.

EAST FRONTS OF THE PALACE OF ELECTRICITY AND VARIED INDUSTRIES BUILDING.

The steam engines which form the link between the boilers and the dynamos, hold a place in the center of the big Machinery Building, where they are bedded on solid earth. Visitors will view them from spacious galleries surrounding the plant on all sides. The operators of the engines are, therefore, in no way interfered with, and the visitors will be in no danger from the engines. This exhibit will include examples of the best work of all the big engine manufacturers of this and other countries. It will include every offered device for transforming the expansive energy of steam into motion—from the time-tried horizontal engine to the recent development of the steam turbine.

For machines working in metal, there are those operated by shock, compression, or tension; steam hammers, trip hammers, and drop forging; machines for cutting, shearing, punching, stamping, countersinking, and shaping; rolls, draw benches, wire-drawing machines; machines for stretching and flanging, and for bending, butting, and welding and riveting. Another interesting sight is the methods of heating, annealing, tempering, cementing, welding, and brazing. There are shown all the tools used with the forge and with the above-named machines, as well as a full display of anvils, vises, hammers, shears, punchers, and dies, and various compounds for metal tempering, welding, and cleaning.

There is a full line of machines with cutting tools, such as machinery for drilling, boxing, reaming, and tapping, and machines for planing, milling, slotting, and grooving. There are machines for grinding with grit, emery, carborundum, and diamond. In the machine and forge-shop equipments, are seen measuring tools and instruments of precision, as well as instruments for testing shapes and dimensions.

Machines for working in wood are to be seen in every variety—for sawing, planing, turning, boxing, moulding, mortising, tonguing, grooving, shaping, and carving, as well as for polishing and veneering. All appliances for wood-working machinery are also shown.

President Engler, of the Worcester Polytechnic Institute, has in operation many of the processes of modern foundry practice. This model foundry exhibits many operations in iron, brass, alumi-

num, steel, and lead, and also has a chemical laboratory. There are here shown fourteen different machines for grinding or sharpening drills of all kinds, together with special devices for demonstrating to the public the accuracy of this grinding machinery and the advantage of accurately ground drills. Here are many novel and striking features to

PALACE OF ELECTRICITY AND MACHINERY HALL, FROM THE TERRACE.

catch the eye, and to interest and instruct the public. The special aim is to furnish an exhibit educational in its character, and one which will demonstrate the value of the instruction found in an up-to-date polytechnic school.

Chemistry and its Varied Branches

All that is modern and ancient is brought together in strong contrast in the treatment of chemistry and its varied branches. To-day chemistry is fast broadening in its scope. It has a tendency to develop more and more along the lines of engineering, and there is a demand for what might be termed the "Chemical Engineer," a mechanical engineer technically trained and with special knowledge of chemical science. The management of the Louisiana Purchase Exposition, recognizing this new important fact, has set aside ample space in the Palace of Liberal Arts for the American and foreign exhibits, to illustrate fully the wonderful progress now being made in the science of chemistry. Aside from the home exhibits, there will be elaborate displays in this line from Germany, Great Britain, France, Italy, and Mexico, which will show the rapid development that has taken place during the last decade.

The allotment of space for domestic exhibitors is in the group of Chemical and Pharmaceutical Arts. A complete chemical laboratory and pharmaceutical workshop is one of the instructive features. Among the foreign exhibits, Great Britain has an extensive display of chemicals in octagonal-shaped glass cases, divided into sections showing different manufactures and classes of chemical and pharmaceutical products.

The chemical display of Germany is on a magnificent scale, as that nation stands in the front rank in the field of chemical manufacture, as well as in all lines of industrial chemical investigation.

One chemical exhibit has a laboratory showing how perfumery is made from flowers. The entire process is demonstrated. On a sheet of glass is placed a layer of

DISPLAY OF RAILWAY SCENERY IN AUSTRIAN PAVILION.

lard, then a layer of leaves of flowers, then another glass sheet treated likewise, and so on until a book is made of these sheets; and then the whole is heated and the oil distilled to get to the basis of flower perfumes. The visitor sees the whole process, from the rose-leaf to the cut-glass bottle of perfume. The display of perfumery products is arranged in

beautiful glass installations pleasing to the eye and in keeping with the business. Along with these are soaps, toilet waters, and the thousand-and-one other preparations sold by druggists to cleanse and keep clean the human form.

History of Electro-Chemicals

The elaborate display of electro-chemicals gives the visiting chemist and pharmacist an opportunity for the first time to see this new industry completely represented. The history of electro-chemistry is exceedingly interesting, showing, as it does, that to-day the inquiring mind of the investigator is finding new applications of old ideas put forth a century ago.

For instance, it was in 1807 that Sir Humphry Davy, who displayed wonderful genius in original research, made remarkable experiments resulting in the isolation of sodium and of potassium by the use of the electric current. By these experiments he not only added to the list of known chemical elements two of its present most important members, but he was the first to devise a method by which an element was isolated through the application of electricity.

Unfortunately, in those days, no cheap source of electrical energy could be obtained. However, the invention of the dynamo in 1867 soon produced electrical energy at low cost; but it was not until 1890 that the electrical current was successfully applied in the manufacture of chemicals. In that year Castner devised an electrolytic process which completely superseded the then used chemical processes for the isolation of sodium, and which was until recently the only process of the kind in use in this country or abroad for the commercial production of that metal. More recently, Darling has devised a process by which sodium is obtained from sodium nitrate.

Up to ten years ago, about the only use for sodium outside of the laboratory was in the isolation of aluminum. Then came the electrolytic method for the production of aluminum, and it looked as if the isolation of sodium on any large scale would cease. It was soon learned, however, that when electricity was applied to the isolation of sodium the metal could be produced so cheaply that its use was possible in fields hitherto closed against it on account of its cost. Chief among these new uses are:—the manufacture of alkaline cyanides, which are so largely used in the extraction of gold from low-grade ores and tailings by what is known as the "cyanide" process; the "quickening" of mercury in gold amalgamation, for electroplating; various processes of typography; and many other uses of minor importance. Large quantities are now converted into sodium peroxide to be used in bleaching wool, silk, and

NIGHT SCENE ON THE WATERWAY.

Machinery Hall on Left.—Transportation Building on Right.

feathers, therein taking the place of the more expensive hydrogen peroxide. Sodium is also used in making certain aniline colors and organic compounds, and wherever a powerful reducing agent is needed.

zontal brass wheel; and in order to print a letter, it is necessary merely to punch one of the buttons, which causes the type to descend through a little tube and make a mark upon a slip of white paper.

The exhibit also includes a model of

PALACE OF EDUCATION (ON LEFT) AND PALACE OF MINES AND METALLURGY (ON RIGHT). View from Festival Hall.

The great electro-chemical display at the World's Fair demonstrates that the chemical industry is only on the threshold of a revolution, for all these wonders by the aid of electricity have been accomplished within the last decade.

Epoch-Making Patents

The exhibit of the United States Patent Office at the World's Fair shows a series of models designed to represent ideas that have made epochs in the industrial history of the world.

So far as possible, the first thing of its kind in every line of human invention is shown. For instance, visitors have an opportunity to see the actual sewing machine which was the first practical contrivance of its kind ever constructed. It was patented in 1846 by Elias Howe. Previously, in 1842, J. J. Greenough had obtained a patent for a sewing machine, which carried the cloth along automatically, having a needle with a hole in the middle.

Equally interesting in its way is the earliest typewriter, which was patented by C. Thurber in 1842. The type keys are set around the periphery of a horithe first cast-iron plow, which was patented by Charles Newbold in 1797; and the first screw propeller, which was invented by Robert Hook in 1680.

CARABAO AND CART USED BY WAR DEPARTMENT FOR TRANSPORTATION IN THE PHILIPPINES.

The invention of the steamboat is credited to Robert Fulton, yet in the seventeenth century Denys Papin launched on the Seine, in France, a boat that was run by steam. It is a matter of historical record that the river barge men smashed Papin's boat because they feared that it would injure their business.

The Ideal Foreman

Qualifications Requisite for His Highest Success

By FREDERICK W. TURNER

Formerly Instructor, Rindge Manual Training School, Cambridge, Mass.

ANY attempt to outline an ideal is apt to be met with many differences of opinion, if not actual denials. One reason for this difference of opinion is found in the fact that ideals are always on a sliding scale. The ideal of to-day becomes the realization of to-morrow, and the point of view depends upon how far up the ladder of idealism the observer has advanced. To borrow an illustration from the shop, probably every workman remembers that on entering the factory as an apprentice, his boyish ambitions were centered on advancing to a position occupied by some workman well up the line, who, in the opinion of the apprentice, was better dressed and had an easier task than his fellows. In the course of time, if the young man was ambitious and persevering, he probably occupied this or a similar position, and then found, to his dismay, that his ideal had changed, and that he now looked forward to occupying the position held by the foreman or superintendent. In other words, viewed from the point of attainment, an ideal is a will-o'-the-wisp, always keeping just beyond our reach. It is well that this is so, for there is no human failure so complete as the man who is entirely satisfied with himself.

From another point of view the ideal is a movable feast, because, to quote an example from our subject, the ideal foreman of the apprentice is not that of the skilled mechanic, while the views of the owner on this subject are almost sure to be at variance with those of any of the workmen. We can readily appreciate how the bright boy idealizes the man who treats him kindly and who gives him an opportunity to learn. The lazy boy feels kindly disposed toward the foreman who gives him an easy task. The poor and careless workman wants a foreman who will pass work which is not a credit to the craft, and who is blind to the evils of laziness and, possibly, to those of the drink habit. The skilled workman asks nothing of a foreman but to be treated like a man, to be given a proper share of the desirable work, and to be allowed to work out his own salvation along these lines. The owner looks to his foreman to make money for him. In many cases, he expects him to make more money than the capital invested and the methods pursued will warrant. This means that the foreman is expected to crowd the workmen to the limit, and to keep both the plant and the help as near the breaking point as it is possible to carry them. Some owners and managers, however, are content with a reasonable return on their property, pursue up-to-date methods, and give to the workmen some thought beyond their mere capacity to earn dividends. It is to be regretted that men of this type are not more often found in positions where their humane policy can be held up as an example to those of a more sordid and grasping nature.

It having been shown impossible to outline an ideal foreman, when viewed from these different standpoints, evidently the discussion of what a foreman should be can be no more than a statement of the personal opinion of the writer.

Before all other qualifications, it is necessary that the foreman should be what the word implies—first, a man;

and, second, a leader. If he is a man in the true sense of the word, he cannot fail to be respected by all self-respecting workmen. If he is an honest leader, he will conduct those workmen along the lines laid down by the owners as the policy of the establishment. Too often the foreman is looked upon merely as the buffer between the firm and the men. He is supposed to act as peacemaker, and to keep them from flying at one another's throats. Under such conditions, it is obviously impossible that a man can be in full favor with either party. Toward the firm the foreman should be respectful, obedient, and energetic; toward the workmen he should be firm, just, and sympathetic.

Of all the qualities going to make the ideal foreman, that of tact is the most important. It means that the men will be treated as individuals, their failings noted and corrected, their good points enlarged upon and due credit allowed for them, and that the shop life will be freer and more natural. With this tact, or faculty of governing along the line of least resistance, must be coupled absolute fairness. Nothing will create such an atmosphere of discontent as a suspicion that the foreman has favorites. If these supposed favorites happen to be relatives of the foreman, the idea is much harder to combat. For that reason, personal friendship and family obligations will be left outside the shop by the man who wishes to succeed as a leader of workmen. A decided, but not aggressive, manner of passing upon questions serves to inspire the men with respect for the foreman, especially if such decisions are rendered promptly, and they prove, in the large majority of cases, to be accurate. Having made a decision, or taken a decided stand on any matter, it will not do to deviate from that position, unless it is so clearly wrong as to be apparent to the casual observer.

Fairness, dignity, and firmness are qualities that can be quite closely defined; but tact and its fellow attribute, executive ability, are rather elusive of close description. They are of the inherited type, and can be cultivated only to a very limited extent. If a man does not possess tact and executive ability, it is useless for him to accept a position where they are essential, in the belief that they will develop as required.

While workmen are supposed to be paid only for the time spent in the shop, it is also true that a man's value cannot be reckoned entirely by the quality of his work and the number of hours of labor. His conduct outside the factory invariably leaves its impress on his conduct within and on the product of his work. This is even more noticeable in the case of a foreman, for, although workmen generally would deny it, they do not and cannot have a wholesome respect for a foreman who is not respected by the community. Men will say they do not care what a foreman is outside the shop; but their better nature will not allow them to look up in any sense to a social pariah.

While an absolute grasp of all the details of the business, viewed from the workman's standpoint, is not absolutely necessary to a foreman possessing tact and executive ability, it adds greatly to a foreman's prestige to be able literally to show any workman just how any operation should be performed.

Just a word in illustration of tact in dealing with men of radically different temperaments. The blustering workman, so familiar to all foremen, can be best controlled by a very quiet and soft-spoken superior, especially if the foreman in question has the reputation of firmness and fair dealing. The quiet, positive statement, coupled with a refusal to discuss the matter, is so contrary to the blatant workman's usual procedure, that it takes away his only weapon by not allowing him to use it. On the other hand, it often happens that the quiet man of few words can be spurred on to better deeds by an energetic and insistent manner on the part of the foreman. Of course, this all goes to prove the foreman's tact, and to disprove the oft-repeated statement that workmen should all be treated alike. The best results cannot be obtained in this manner. Until men are all turned out in the same mould, it will be necessary to suit the treatment to the temperament of the man.

The question of how far it is advisable to show sympathetic nature, is one of grave doubt. Sympathy does not mean that excuses are to be taken literally;

but a casual inquiry as to how the sick wife or baby is getting along shows an interest outside the commercial relation that appeals to most men. The old saw, "You catch more flies with molasses than you do with vinegar," has an application in the treatment of workmen by their foreman.

Another question which has more than one answer, is whether it is better to have a foreman promoted from the ranks or to get an outside man for the position. The man from the bench is familiar with all the shop traditions and practices, and can keep things going with hardly a break. On the other hand, he is the victim of jealousy and spite, and, unless exceptionally well-poised, is apt to assume an attitude toward his former shopmates which might be termed "dignity gone to seed." Every youthful indiscretion is remembered, and any attempt to check such antics on the part of the younger men is held to be an unwarranted assumption of dignity. On the whole, the attempt to promote a foreman from the floor or bench is fraught with difficulties; and many a man who would have made an excellent foreman in another shop, has been a rank failure in that capacity when tried among his old shop associates. The foreman taken from the outside stands or falls, as far as the workmen are concerned, on his record in his new position. He is not condemned for past faults. Furthermore, he should be able to bring into his new associations some of his experience in former situations which will be of value to his new employers. It is an infusion of new blood, is often the means of discovering leaks and weaknesses not noticeable to the old employees.

A foreman's value to a firm depends largely on his knowledge of the capacity and limitations of each man under him. This knowledge enables him to lay out his work to the best advantage, as he knows the man who is quick, the man who is accurate, and the man who can be trusted to carry along detail or experimental work. To keep a man up to his best pace, to have new work laid out for him in advance, and to keep that man satisfied with his work and wages, is a task that taxes the ingenuity of the best of foremen. The matter of repairs, especially those of a petty nature, is one which tests a foreman's commercial sense more than the regular run of work does. As an example, suppose that the friction on a countershaft slips; shall the oiler be sent for while the machine operator waits; shall the workman fix it himself; or shall the man be transferred to another machine while the repair work is going on? Of course, this all depends on the nature and degree of the difficulty; but it affords an opportunity for quick and accurate judgment on the part of the foreman, and demonstrates his fitness to cope with emergencies.

An article of this character should not be closed without a reference to that old-time figure, the "working foreman." Do not all machinists of mature age remember how the foreman would walk down the shop with a piece of work and a file in his hand, filing as he went? Even in these days of strenuous competition, we sometimes see an advertisement for a "working foreman." It is preposterous to think that a foreman can properly supervise the operations of more than a dozen men, and do any work that calls for close attention. Many firms insist on this practice, however, and are daily losing money by its continuance. A foreman should be devoting his energies to the development of better methods of manufacture, and not to the production of work that could be performed by one of the machinists.

And so we leave the ideal foreman, not yet discovered, not even closely defined, but anxiously awaited and badly needed.

ROGERS BUILDING, MASSACHUSETTS INSTITUTE OF TECHNOLOGY, BOSTON, MASS.
Containing the Offices of Administration.

Great Technical Schools

Massachusetts Institute of Technology, Boston, Mass.

By A. E. ZAPF, S. B. (M. I. T., '95)
Secretary, American School of Correspondence.

FOUNDED A GENERATION ago for the purpose of developing industrial leaders through study of applied science, the Massachusetts Institute of Technology has been urged forward with some aid from the Commonwealth whose name it bears, but mainly through the strenuous exertions of a group of devoted adherents, until it has become a school of national and even international importance. It has always been a popular as well as scientific and technical success.

Plans are now under consideration by which the Institute may be removed from its present situation in the aristocratic Back Bay section of Boston, where land values have advanced to such an extent that further expansion has become very expensive, and relocated in one of the suburbs.

In the thirty-eight years of its existence the Massachusetts Institute of Technology—or "Tech," as it is popularly known—has graduated about 3,000 young men, as well as a small number of young women, and has given from one to four years of instruction to about 5,000 other students who, for various reasons, were not graduated. During this time the institution has established thirteen separate courses, has

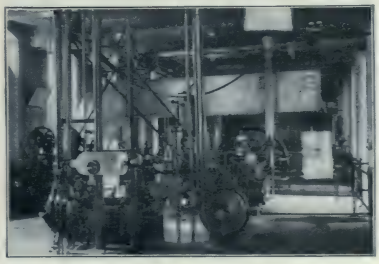
HENRY S. PRITCHETT, LL. D.
President, Massachusetts Institute of Technology.

accumulated property valued at about $4,000,000, and has erected a large number of buildings admirably adapted to the purposes of scientific study. Accord-

WALKER BUILDING.
Named in honor of the late President Walker.

ing to the latest catalogue the total attendance in all departments was 1,683. Among the enrolled students are many graduates from other colleges and universities.

Architecturally the Institute is not pretentious, although the Rogers and Walker Buildings, its two most conspicuous structures facing on Boylston Street, the main thoroughfare of the Back Bay district, are fairly imposing. The other buildings, however, are for the most part severely plain in both exterior and interior. Within them, however, is found one of the most complete systems of lecture rooms and laboratories ever established. It is, in fact, primarily the possession of numerous well-equipped laboratories which makes Tech so admirable a place for the study of Applied Science. In these laboratories students are kept busy under instruction, not merely over academic propositions, but, in many cases, in serious attempts to solve problems of real moment to the world, such as the purification of sewage, the utilization of the by-products of flour-milling, the prevention of deterioration in canned goods, etc. A recent writer has coined the term "Wonderful Technology" as ap-

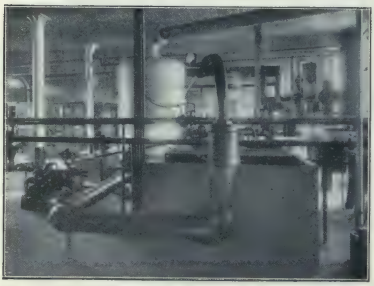


One of the Mechanical Engineering Laboratories.

plicable to the marvelous ingenuity shown in adapting the requirements of the laboratories to the buildings in the heart of a great city.

It should be said that the Massachusetts Institute of Technology is a school to which, for the most part, only those students go who purpose doing work of a sustained and rigorous character. The school has always been noted for the

ENGINEERING AND PIERCE BUILDINGS.
Engineering Building (A) on left. Engineering Building (B) in center. Pierce Building on right.



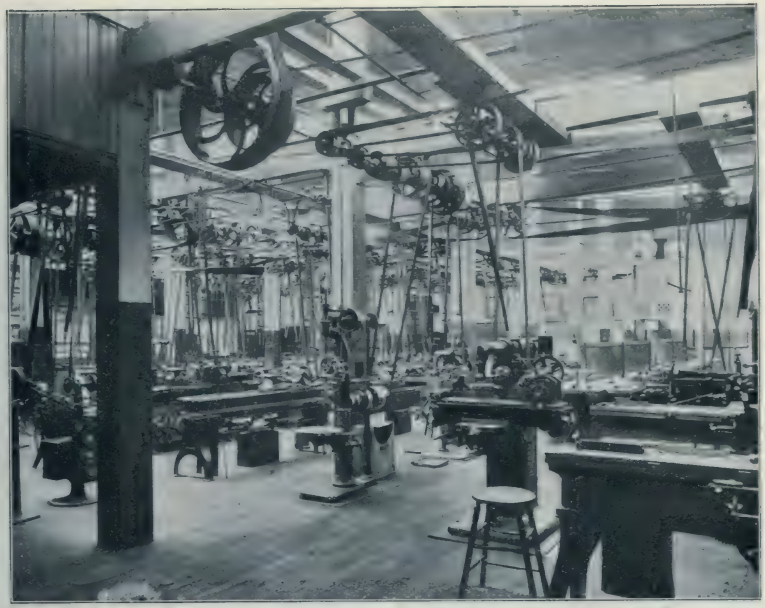
A Corner of the Hydraulic Laboratory.
Mechanical Engineering Department.

high standard of its requirements and for the general spirit of serious investigation that prevails. True, certain social features have lately been developed—such as the Technology Union, which brings the students together in a pleasant way, and the Technology Club—but the social element enters far less into the life of the institution than in most of the colleges and universities of the country. The Institute is essentially a great professional school—a great educational workshop. It offers at present thirteen distinct courses, each one of four years' duration, covering the following subjects: Civil Engineering, Mechanical Engineering, Mining Engineering and Metallurgy, Architecture, Chemistry, Electrical Engineering, Sanitary Engineering, Geology, Naval Architecture. For the satisfactory completion of any one of these courses, the degree

Beam-Testing Machine.
Mechanical Engineering Department.

of Bachelor of Science (S. B.) is conferred. Women may be admitted to any of the courses of the school.

There is also for advanced students of technological subjects a Graduate

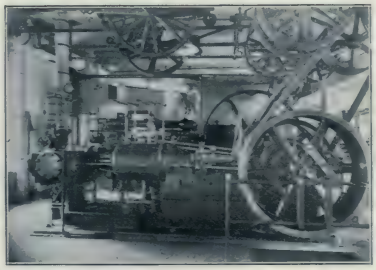


MACHINE TOOL LABORATORY.
Mechanical Engineering Department.

School of Engineering Research which gives the degree of Doctor of Engineering. This department of the Institute's work is new, and is one that seems destined to draw to Boston graduates of other schools who wish to carry on special investigation in important engineering problems. The degree of Doctor of Philosophy (Ph. D.) is also given under conditions generally similar to those prevailing in the universities such as Harvard and Johns Hopkins.

THE FORGING LABORATORY.
Mechanical Engineering Department.

To describe in detail the work of each of the thirteen departments would make a very long article. It may, however, be interesting to refer briefly and suggestively to a few of the things that are being done in the Institute, on the principle that

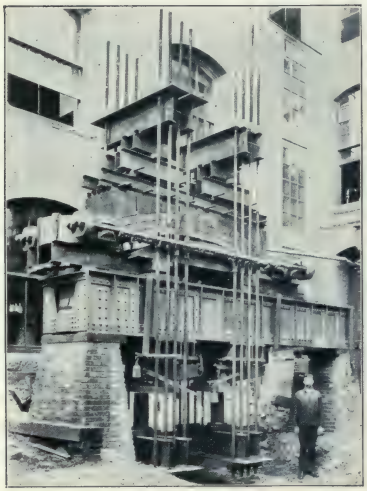


250-H. P. HIGH-SPEED ENGINE.
Mechanical Engineering Department.

these afford an example of what is done throughout.

Naval Architecture

A very important department of the work of the Institute, and one that has been particularly prominent of late years, is that of Naval Architecture. Until within five or six years ago, American



Masonry Arch Testing Machine.
Mechanical Engineering Department.

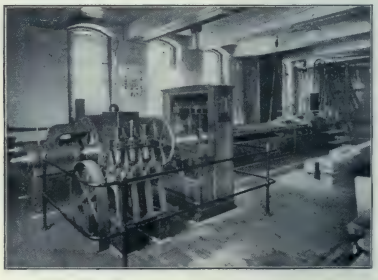
shipbuilding experts were nearly all trained abroad. Now, the Massachusetts Institute of Technology, which, from its proximity to one of the great governmental navy yards and one of the leading shipyards of the country, is particularly well adapted to giving instruction in this science, has built up so strong a school of naval architecture that the United States Government is regularly sending graduates of Annapolis here to complete their course for appointment as naval constructors.

Electrical Engineering

Another very strong department is that of electrical engineering. Boston, by reason of its interests in great plants at Lynn, Mass., and Schenectady, N. Y., in the practically universal Bell telephone system, and in various electric transportation enterprises in all parts of the world, has always been a center of electrical experimentation and manufacture, so that students naturally find abundant opportunities for critical study in the field of applied electricity. In 1885, but two students in Electrical Engineering were graduated from the Institute; to-day there are more than 200 young men studying this one general subject; and of these it is interesting to note that about one in every six becomes a telephone engineer.

A short time ago a new electrical laboratory was dedicated, built as plainly as a factory, but surpassing anything else of the same kind in the world in equipment and convenience. Neither France, Germany, nor Great Britain—not even the important German institutes, such as the Imperial Physical Technological Institution at Charlottenburg—has anything superior to this laboratory, which has been named the Augustus Lowell Laboratory of Electrical Engineering, in honor of a distinguished benefactor.

The Lowell Laboratory is divided into five important working parts: the power room and main laboratory, closely akin to a big commercial institution; the smaller research rooms, based upon a study of the facilities which in Germany are



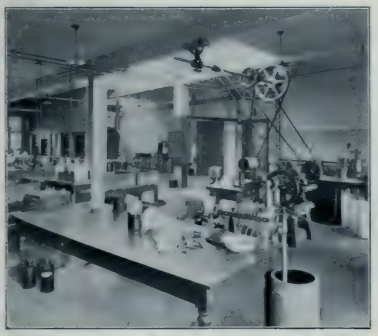
Emery Testing Machine.
Originated by Lieutenant Emery, United States Army. Second largest Beam-Testing Machine in existence. Capacity, 300,000 pounds.

placed at the disposal of the special research worker; a standardizing room; a lecture room said to be the most complete in the world; and, finally, the workshop, where the mechanicians of the Institute repair and, indeed, manufacture a great deal of the laboratory apparatus that is used thro ghout the school.

These rooms, grouped in a single large building, cover an area of about 40,000 square feet. The structure is only one story high, and is so well lighted by

THE CHEMICAL LIBRARY.
One of the largest and most complete libraries in existence devoted exclusively to chemistry.

seventy skylights that each room has the steady, well-diffused light of an artist's studio. In the power room, which is naturally the heart of the laboratory, are six permanent dynamos with their accompanying engines, aggregating more than 1,000 horse-power and furnishing current for light, motor power, and experimental service. The actual experimental work—that is to say, the testing of all kinds of electrical apparatus in all their multiplicity of details—is conducted

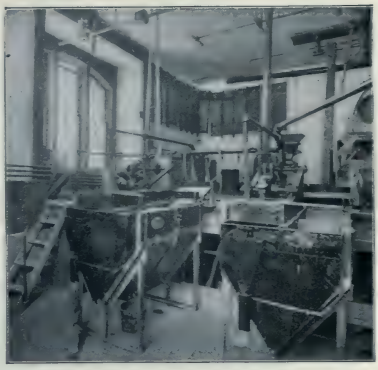


LABORATORY OF INDUSTRIAL CHEMISTRY.

by a large number of smaller dynamos, which a 10-ton overhead crane running the length of the 300-foot hall carries back and forth as experiments require.

Mining Engineering

Mining engineering is another favorite profession with Massachusetts Tech men. Boston capital, as all the world knows, has been very active in developing mining properties throughout the West, and most of the actual work of opening and successfully operating the mines has for many years back been directed by graduates of Technology. The student does not find Boston such a bad place for learning the lessons he will have to apply in Butte or Dawson, for, although situated far from any mining center, the Institute has complete apparatus for carrying on all the mining operations. Indeed, the basement of Rogers Building, in which this instruction is



COLLUM JIGS.
Mining Engineering Laboratory.

given, has very aptly been termed "Montana in a cellar." Far down under the Rogers Building, one finds oneself surrounded by a multiplicity of machines and a general atmosphere of smoke and soot that suggests a combination of Leadville, Houghton, and Anaconda. Here, for instance, is the laboratory of metallurgical chemistry, with a complete equipment for qualitative and quantitative analysis of ores, with curious retorts, glass tubing, amalgamating pans, "collum jigs," "frue vanners," and all the rest. Every branch of mining is studied effectively and economically.

To supplement the regular laboratory work of this department, summer excursions of students of Mining Engineering go forth each year to study the metallurgical processes in actual, practical op-

eration. One year perhaps a party visits northern Michigan for six weeks of constant observation on the present methods of extracting copper. Another summer finds the young Tech enthusiasts on Cape Breton Island, Nova Scotia, where a combination of the best American and British practices in handling coal and iron is to be observed. Again, the following summer, Montana or Arizona give opportunity to see interesting types of mining. The summer work in this, as in many other departments of the Institute, is regarded as very important.

Other Engineering Courses

A profession which has come into prominence of late is that of Chemical Engineering, and still another is Landscape Architecture, in both of which the Massachusetts Institute offers good courses. Courses are given under the head of Mechanical Engineering in such important pursuits as mill engineering, the construction of locomotives, heating and ventilation; in architecture; and in structural design.

Special Laboratories

The system of special laboratories is singularly comprehensive. Here, for example, is the only technical school laboratory in the United States devoted to sugar analysis; and here is a laboratory opened during the present year for study of methods of sewage purification.

ARCHITECTURAL EXHIBITION ROOM.
In this room is displayed the work of the Students in the Department of Architecture.

The last-mentioned laboratory may be taken as a particularly good example of the readiness with which the Massachusetts Institute of Technology has always

LIFE CLASS ROOM.
Department of Architecture.

coöperated with the community in the midst of which it is situated, in the solution of its problems. The new laboratory has been located at the junction of two main sewers of the Boston system, and is devoted to the very practical work of experiments with the aërobies, anaërobies, and other minute organisms, which can be of important use in the destruction of the deadly microbes that infest sewage. The subject is one of vital interest to every city in the world, and the results that are being achieved by the Technology investigators are already attracting very general attention.

Extension Work

One laboratory of the Institute, which is perhaps not yet mentioned in the Announcement of the courses of instruction, deserves particularly to be mentioned. This is the Real Life Laboratory known as "Tech House," and devoted to practical sociology in a tenement-house district of the city of Boston. It differs radically from the ordinary college or university settlement in that its work is based upon the idea of helping prospective engineers, who will later have to mingle constantly with workingmen, to get early in touch with the toilers, and thus to apprehend both the conditions in which they live and their intellectual attitude toward their work. The headquarters of the settlement is to all intents and purposes a Technology dormitory at which half a score of students live, assisted in their undertakings by 80 or 90 other students who give up part of their time to the work of directing boys' clubs,

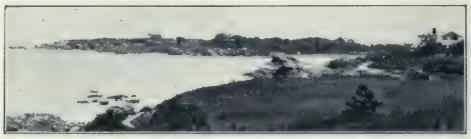
MODELING ROOM.
Department of Architecture.

debating societies, reading classes, and courses in manual training, telegraphy, chemistry, steam engineering, and similar subjects. The dining room of Tech House is one in which labor leaders frequently meet with college professors and other representatives of the higher education, for profitable discussion of economic and sociological as well as engineering problems.

PROFESSOR SEDGWICK LECTURING ON BIOLOGY.

The history of the Massachusetts Institute of Technology may be briefly re-

ferred to. The school originated in a memorial prepared in 1859 by Prof. William Barton Rogers and presented by a committee to the Massachusetts Legislature the following year. In this memorial, reference is made to the expected early establishment of a "comprehensive polytechnic college, furnishing a complete system of industrial education supplementary to the general training of other institutions, and fitted to equip its students with every scientific and technical principle applicable to the industrial pursuits of the age." Various propositions and consultations followed; but the actual opening of the Institute was postponed until after the close of the Civil War. The first regular session, under the name of the School of Industrial Science, was opened February 20, 1865. The regular courses of instruction in the Massachusetts Institute of Technology began October 2, 1865. Under the presidency of the late Gen. Francis A. Walker, the Institute attained its well-established fame. Its present head is Dr. Henry S. Pritchett, known throughout the country as the former head of the United States Coast and Geodetic Survey, and as an educator of international reputation.

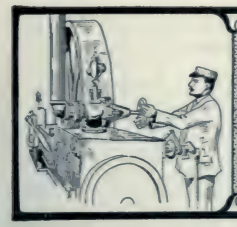


The Craftsman

By PHEBE A. HANAFORD

By craft the wealth of men and nations grows,
That wondrous union of the hand and brain
Which gives to human handicraft the power
To work such change as bread from golden grain.
Then honored be the craftsman by whose skill
The home is made more bright, and easier far
The toil of those whose presence cheers the heart,
As night's dark skies are brightened by each star!
And blest be Labor which can deck its wares
With grace and beauty, for the cot and hall,
To give the artisan an honored place
Beside the artist held in praise of all:
Since craftsmen's skill can Art's successes gain,
And win the wealth such prizes to attain.

—*The Craftsman.*



ENGINEERING PROGRESS

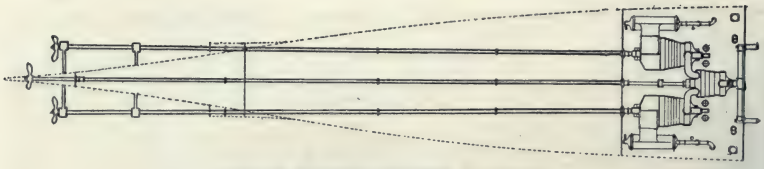
First Trans-Atlantic Turbine Steamer

TO HAVE A STEAMSHIP which would cross the ocean between Europe and the United States in the shortest possible time, has been the ambition of every Trans-Atlantic Company since the days of the old *Great Western*. At the present time the first-class ships of most lines make the trip in about the same number of days, so that, as far as speed is concerned, there is little to choose from. The Allan Line, however, is the first of the trans-Atlantic companies to adopt one of the most noteworthy of recent advances in engineering. This enterprising company has contracted with Workman, Clark & Co., of Belfast, Ireland, for the building of a first-class steamer for their Canadian mail service, fitted and equipped with Parsons turbine engines.

Admirable as are the arrangements of the *Victorian* for the comfort of 1,300 saloon passengers, and her facilities for the rapid handling of 8,000 tons of freight, it is to the machinery of this vessel that special attention will be directed, as the *Victorian* is the first Atlantic liner in connection with which it is proposed to demonstrate the efficiency of the turbine for large steamers. It is now affirmed that the turbine, as compared with the reciprocating engine, can legitimately claim a saving of weight, space, and cost, and a complete absence of vibration; while the smooth, continuous action of the turbine, with no rubbing surfaces and no thrust friction, makes it an ideal marine engine.

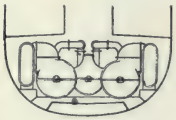
NEW TURBINE STEAMER *VICTORIAN.*
The First Vessel of this Type in Trans-Atlantic Service.

SECTIONAL ELEVATION.



PLAN OF TURBINE STEAMER *VICTORIAN.*

The speed of the *Victorian* will be a great advance upon that of any steamship now on the Atlantic route. The builders



SECTION THROUGH ENGINE ROOM.

SECTION AT AFT END.

confidently expect that under reasonable conditions the voyage from England to Canada will be shortened by more than a day, so that this vessel of the Allan Line may prove the pioneer of a new type of ocean steamers.

House Moving Extraordinary

ONE OF THE MOST REMARKABLE FEATS in house moving ever attempted, has been successfully performed in the suburbs of Pittsburg, Pennsylvania.

Some time ago the Baltimore & Ohio Railroad Company purchased the homestead of William Brown in order to use the lot for an extension of its tracks. As the accompanying cut shows, the main portion of the house is 2½ stories in height, with a wing; and the building is very substantially constructed of brick. It formerly stood at the foot of a bluff which is nearly 100 feet high. Rather than construct a new home, the owner decided to elevate the old house to the top of the bluff; and he let a contract to a firm of house movers to undertake the work. During several months past the entire building was in the process of journeying upward in the remarkable manner shown in the photograph. In spite, however, of the size and great weight of the house, the work was successfully accomplished. So carefully had the building been supported, that neither the walls nor the ceilings were cracked; and the only work required of the builder was the excavation of the cellar on the new site, and the erection of the foundation on which the structure was to rest.

When it was determined to start the building on its upward journey, the cellar walls were first cut away and jack-screws substituted. Inch by inch the building was elevated on the jack screws; and timbers were placed beneath, being

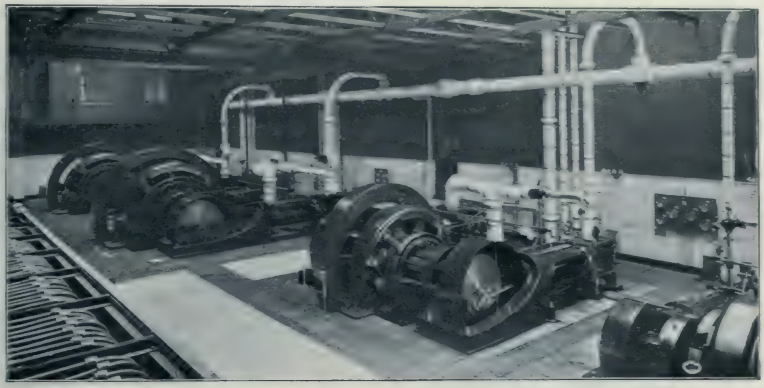
HOUSE MOVING IN PITTSBURG.

The brick house here shown was raised over the bluff nearly 100 feet high.

so distributed that the weight would be equally sustained. Then the screws were moved to the top of the shoring, and the house again moved upward. Thus the work progressed until the building reached such a height that it was necessary to use a derrick in order to raise the upper timbers supporting it.

The accompanying photograph was taken at about the time the journey was two-thirds completed. The cost of ele-

vating the house was equivalent to about as much as would be required to build two houses of its size; but the owner wished to make it his life-long home on account of the associations connected with it, and ordered the movers to carry out the work regardless of expense.—D. A. Willey.



POWER ROOM, WITH DYNAMOS AND ENGINES, GOVERNMENT PRINTING OFFICE.

Government Printing Office

ONE of the most interesting power plants in the United States is that installed at the new Government Printing House at Washington. As is well known, this establishment is one of the most complete of its kind in the world, and has the reputation of being the largest printing office under one roof. To prepare the various publications, requires no less than 125 presses in addition to other apparatus, and the majority of these are operated by individual electric motors. Consequently the power station contains a series of electrical units which are notable for their size and current-producing capacity.

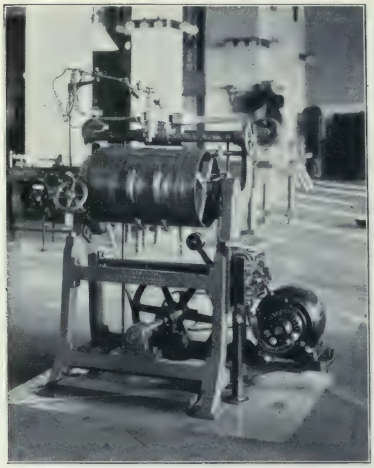
As indicated by the illustration, the generators are direct-connected to the engines which operate them, and consist of four in number. Each generator is of the 110-volt type. One represents 125, one 300, and two 500 kilowatts' capacity. They are compound-wound, the largest weighing 42 tons. When running at full speed, the generators perform 100 revolutions per minute. The engines are of the cross-compound-condensing type, one being of 200, one of 450, and the two larger of 800 horse-power each. The power units are arranged in a series, the current being conveyed from the generators to the various departments by

GOVERNMENT PRINTING OFFICE, WASHINGTON, D. C.

means of cables from which wires lead to the individual motors. The generating room is adjacent to the boiler-room, steam being transmitted to the engines by the method shown in the illustration, to develop the necessary horse-power. A battery of eight boilers has been installed, of the Scotch marine type, arranged in

two nests of four each. They have a total capacity of 2,400 horse-power, all being of the same size.

The plant has been in operation about a year, but since it was started, has been visited by a number of eminent steam and



CIRCULAR ELECTRO ROUTER IN GOVERNMENT PRINTING OFFICE.
Driven by Electric Motor.

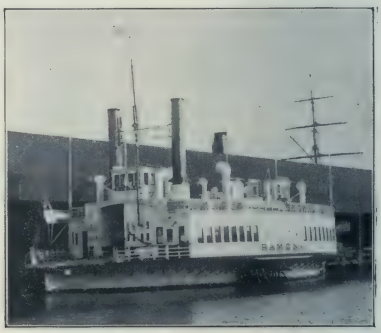
electrical experts who have made a critical inspection of it. The general opinion is that it is as perfect in its equipment as any power plant in the country, and performs a very extensive service considering the horse-power utilized and the size of the generating sets. D. A. W.

Oil as Fuel on Ferryboats

RECENTLY a somewhat novel craft has been built and placed in service for ferry purposes in the harbor of San Diego, California. The exterior of the boat differs but little from that of the ferryboats in common use along the Atlantic coast, but her machinery is radically different. She contains two engines developing a steam pressure of 150 pounds to the square inch, and having an indicated horse-power of 670. Steam is supplied from two boilers of the gunboat type, each of which is 16 feet in length and 7¾ feet in diameter, containing tubes which are 3 inches in diameter. The boilers are tested to 225 pounds to the square inch, and have oil-burning furnaces, the fluid being thrown upon the fires in the form of spray, by the use of steam jets.

The *Ramona* is one of the largest ferryboats on the Pacific coast, being 130 feet in length and 29 feet in breadth of hull, which is constructed of Oregon pine. She was built at the Risdon Iron Works of San Francisco, and made the voyage to San Diego under her own steam without any convoy, although she was obliged to go nearly 500 miles on the open sea.

The oil supply is stored in circular steel tanks located at such a distance from the



FERRY STEAMER "RAMONA," SAN DIEGO, CAL.
In this vessel oil is used as fuel.

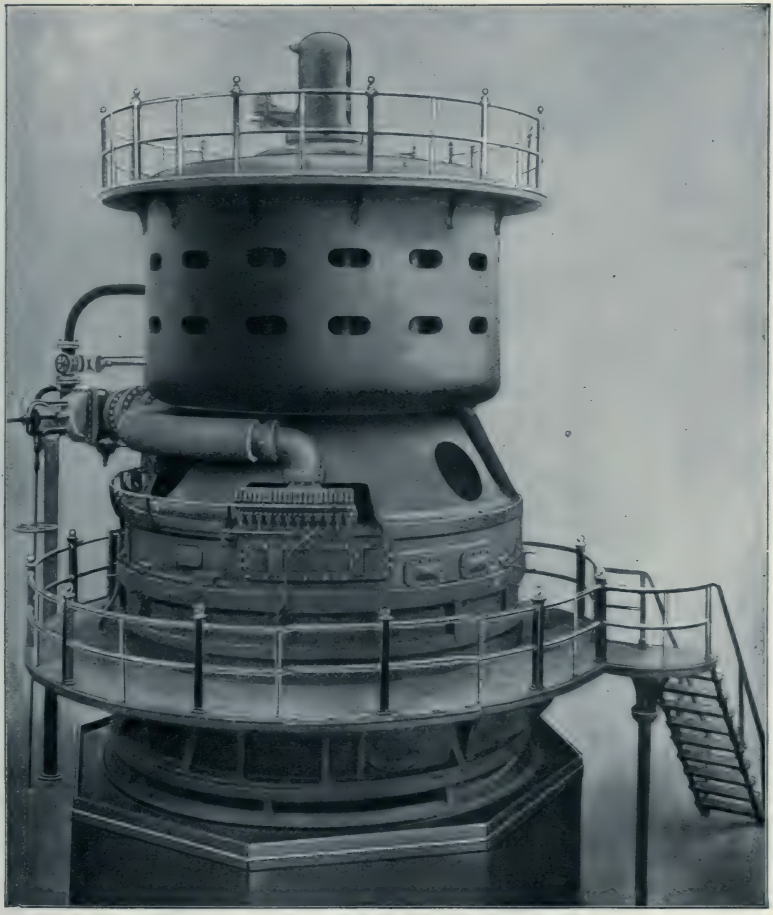
furnaces that there is no danger of ignition. It is conducted by pipes in the usual manner to the furnaces, which are of the corrugated type. The steamer has been in service for nearly a year, and thus far the mechanism has given entire satisfaction.

Large Steam-Turbine Generator

THE NEW POWER STATION of the Commonwealth Electric Company, now partially completed, at 22nd and Fisk Streets, Chicago, Ill., stands upon an area of 600,000 square feet, with room for growth of nearly 200,000 square feet additional. This station will eventually contain fourteen Curtis turbo-generators of the General Electric Company, each of which has a capacity of 10,000 horse-power. At

the present time there are installed two of these generators, and a third is in process of erection. Each generator is operated by a bank of boilers, eight in a battery, receiving superheated steam

bine contains parallel rows of crescent-shaped paddles or buckets on which the steam impinges, and which are directly connected to the shaft and therefore communicate motion to the generator. In

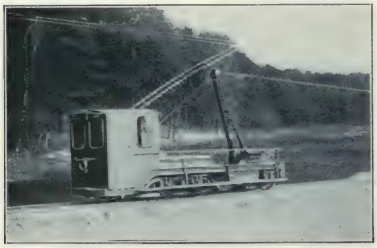


A 10,000-H. P. GENERATOR, DRIVEN BY CURTIS STEAM TURBINE.

(150°) at 175 pounds' pressure, and exhausting to a vacuum of 27 or 28 inches.

The turbine is in two distinct sections, and receives steam in two stages, the first at boiler pressure (175 lbs.), and the second at atmospheric pressure. Each turbine contains parallel rows of crescent-shaped paddles or buckets on which the steam impinges, and which are directly connected to the shaft and therefore communicate motion to the generator. In the upper section, steam is admitted through three ports, each of which contains twelve nozzles, which in a way are inverted funnels, the wider portion being directed at the buckets. Expansion takes place in these nozzles, and the steam here

attains a much higher velocity than from boiler pressure. In the lower section, the steam is admitted at atmospheric pressure through nozzles which are already around the outside case, and impinges



Electric Towing Engine Used on Teltow Canal, Germany.

upon a series of buckets until all power absolutely is exhausted, and discharge takes place through the condensory.

The turbine is directly connected to a General Electric Company alternating generator—normal output 10,000 horsepower; voltage 9,000; 25-cycle; three-phase; star-connected; neutral-grounded. Leads from this generator will communicate to an immense switchboard, constructed by the same company, and situated in a switch-house some forty feet from the turbine house. There is no switching whatsoever done in the turbine house, although electric control enables the board to be operated from either point.

At the present time this station is supplying some thirty (30) substations throughout the city, the largest customer being the Lake Street Elevated Railroad. Condensing water is received from the eastern slip of the Chicago River, and discharged into the western slip, the total length of tunnel being about 600 feet. In this way cold water only is received, and the heated water is discharged at a remote point.

The entire plant is finished in white tile, and no expense has been spared to make it the most up-to-date and the most efficient generating station in the country.

Towing by Electricity

A REMARKABLE INSTANCE of the application of electricity to the towing of boats and barges is that now in operation on the Teltow Canal, near Berlin, Germany, where the use of horses and steamers has been entirely superseded. The engine used on this system not only draws a greater load and travels at greater speed, but is cheaper than the means formerly employed for purposes of haulage, on account of its low working expense. It also saves the great expenditure formerly necessary for keeping the canal in repair, as it does not injure the banks and bottom

Barge Towed by Electricity on Teltow Canal, Germany.

of the canal in any way. Before deciding upon the system to be used, the Teltow Canal Administration offered prizes, which were keenly competed for by twenty inventors. In the system selected, the power is obtained from a specially built generating station, the current being conveyed by overhead wires.

Life Stories of Successful Men

James J. Hill

From a Canadian Farm to the Presidency of a Great American Railroad System

By HENRY M. HYDE

Editorial Writer on the *Chicago Tribune*

THE DIFFERENCE between "Jim" Hill and most of his competitors in the railroad business is that Hill *knows*, while the rest of them *guess*, or, at best, *estimate*. Hill's thirst for exact and accurate—and therefore technical—knowledge has always been one of the prime causes of his tremendous success.

That is the way the case is put by a man who has dealings in a professional way with almost all the great railroad kings of the present generation. And when the wonderful and romantic story of the career of James Jerome Hill comes finally to be written, the questions Why? and How? will stand like lamp-posts all along the path.

In 1856 Mr. Hill, then a boy of eighteen, borrowed money to pay his fare to St. Paul, an obscure village on the upper waters of the Mississippi. To-day a short, heavily-built man of sixty-six, with a short, roughly trimmed iron-gray beard, a bald head covered on the sides and at the rear with a thick thatch of long iron-gray hair, his wealth is estimated at one hundred millions of dollars.

Between the two extremes lies a record of achievement which should be sufficient to put iron into the ambition of the most sluggish youth.

Near Guelph, Canada, lived a Scotch-Irish farmer. He had several sons. Though a poor man, he was ambitious for the future welfare of his boys, and he gave them the best education in his power. They went to school in season, and during vacations toiled on the farm. Thus early they learned the tremendous lesson of hard work.

One day a stranger rode up to the farm on horseback. He stopped for refreshment. One of the boys, Jim by name, fed and watered the horse, and asked its owner more questions about the world outside than he could easily answer. When he rode away, he threw to the waiting boy a month-old copy of a New York paper. That paper told wonderful stories about the fertility and the prospects of the new Minnesota country, not long opened to settlement. Long the boy pored over that paper. Time and again he read the story of the new Minnesota country.

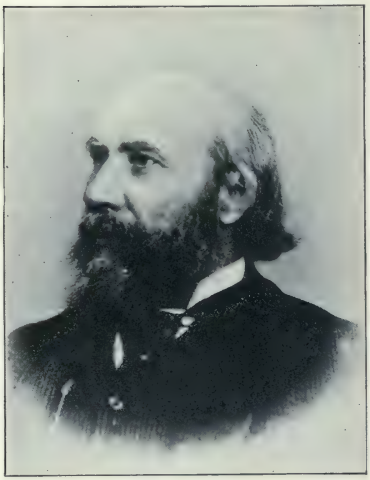
Finally he announced to the other members of the family that he was going West—going to St. Paul. They smiled, perhaps, at his enthusiasm. But he went, borrowing the money to pay necessary expenses along the way.

When he got to St. Paul, it was a frontier post. There was no railroad for many a long day, and the boats that then plied the great river were few and irregular. But Jim Hill went to work at once. He got his first "job" down at the docks on the river bank—from the very first he was interested in the great question of transportation.

At that time St. Paul was one of the great centers of the fur trade. From the Red River country of the North, the fur traders came slowly toiling down to a market, bringing their season's furs in the curious old Red River carts, mounted on two huge wooden wheels and each drawn by a single ox. Hill found time to investigate the possibilities of this business thoroughly. Presently—the interval representing a good many years of hard work and hard study in "leisure"

hours—he got together means enough to organize, with outside assistance, a line of steamboats on the Red River.

At this time a large part of the country which now makes up the great tier of states from Lake Superior on the East to Puget Sound on the West, was marked on the maps as the "Great American Desert." On dog sledges, Hill explored a great part of this territory, and he



JAMES J. HILL, PRESIDENT GREAT NORTHERN RAILWAY.

learned that it possessed wonderful possibilities. All it lacked was cultivation. Cultivation meant settlers; and settlers—to Jim Hill, at least—meant some means of ready transportation.

For a number of years, men of large imagination had been trying to get built a transcontinental railroad. Almost every little track which was laid down along an east-and-west line was called a "Pacific" railroad, though it might not run more than a dozen miles all told. On one such failure, certain Dutch capitalists had spent many millions. When Hill took hold of it, it was nothing but "two streaks of rust, running nowhere in particular across the prairie." Hill interested Sir Donald Smith and other Canadian capitalists in the purchase of this Minnesota & Pacific Railroad, had himself elected general manager, and so began to realize the ambition of his life's work.

Soon after he took control of the road, Mr. Hill announced that he should build it through to the Pacific coast. A good many wise people laughed, for they knew the struggles which had marked the progress of the other Pacific roads, aided though they were by immense grants from the Government. Directly to the south of the Great Northern, as the Hill road came to be called, lay the Northern Pacific; directly to the North was the Canadian Pacific, also backed by Government subsidies. What show was there for a third road between the other two, through a desolate and mountainous country and without Government backing of any kind? The new road, however, had the backing of James J. Hill, and that proved to be all it needed.

In the first place, Hill knew all this vast Northwest as most men know their dooryards. With the eye of an engineer, he had surveyed all its possibilities. He was able to locate "feeders"—short branch lines—so that they would bring in big loads of freight to his main line; he personally purchased and presented to the settlers along the Great Northern hundreds of pure-bred cattle and thousands of blooded swine.

"They were all raising wheat," says Mr. Hill, "and when wheat did not make a crop, they were all broke, and there was no business for the railroad. I wanted to get them into the way of raising live stock, too, as well as wheat."

The effort was so successful that to this day the Great Northern carries vastly more cattle and hogs to Eastern markets than its competitors.

When bridges were to be built, and great cuts and fills to be made across the crest of the Rockies, Hill studied out those problems for himself. He knew the load a beam would carry, and the strain which could safely be put on a girder, as well as did any one of his engineers. Men soon found there was no use trying to fool this inquisitive railroad president. When they took refuge in professional technicalities, he met them on their own ground, and soon penetrated the sham—if sham there was.

They say on the Great Northern that

Jim Hill knows the condition of every rail and tie in the whole system—not only along the main line, but on all of its branches. He went prying into section shanties; and the section men discovered that he knew their work as well as the best of them—better than most. Further than that, he insisted on keeping them all up to their work.

In every branch of railroad work, Hill played the part of a sponge, soaking up all the available knowledge and keeping it stored away somewhere in that big, bald head of his. Lazy and incompetent employees were and are afraid of him. They may well be. It is an old saying that nobody can shirk his work on the Great Northern. The "old man" knows the game too well, too thoroughly, to make such an attempt successful.

When Hill finally pushed the Great Northern through to the Pacific Coast, he found there a market for some of the products of the East; but there was nothing produced on the Coast which could be profitably used to load the freight cars for their return trip; and to haul the cars back empty was to lose money. Hill knew that the chief resource of the coast country lay in its vast forests. The freight on lumber, however, was sixty cents from Puget Sound to Lake Superior, and that left no margin of profit.

"How low a rate shall I make you?" he asked the lumbermen of Puget Sound. "At what rate can you profitably ship your lumber east?"

"Make it fifty cents," they said, hesitatingly. But there the one great controlling characteristic of the man stepped in and took charge. He was not willing to take even the word of the Pacific Coast lumber dealers on this matter in which they were so vitally interested. He went down to Chicago, and personally made a study of the lumber business. By carefully calculating the cost of producing and transporting lumber from nearer sections to that great lake port, he discovered that the Puget Sound lumbermen would not be able to meet the competition of this lumber unless the freight rate from the Pacific was fixed at less than fifty cents. He came back home, and, in the face of their request for fifty cents, made the rate forty cents. As a result, he had no more trouble in getting east-bound loads for his empty cars.

It would be interesting to describe the further development of the Great Northern railroad system, for in fiction there are few stories of achievement more remarkable. Enough, however, has been told to make clear the one great lesson which a young man may learn from the career of James J. Hill. It is that to-day, more than ever before, "Knowledge is power." And the most powerful kind of knowledge is that exact and accurate knowledge which the technical student has an opportunity to acquire.

Dinner-Pail Philosophy

The office with no salary attached generally seeks the man.

Life is an up-hill struggle for the man who is his own worst enemy.

In order to have things come your way, you must go after them.

The meek may inherit the earth, but that does not hinder the hustler from getting possession of it.

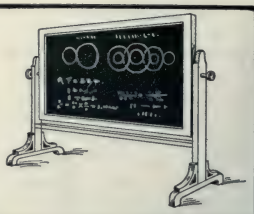
Men should live within their income when they can't live without it.

There is always room at the top, but it is necessary to go a little higher each year.

A man usually has very clear ideas of what the world owes him, but seldom troubles to think what he owes to the world.

CHALK TALKS

by CARL S. DOW.



Number Five.—Ohm's Law.

WE ALL KNOW that water will flow from one level to a lower one if there is no obstruction to the flow. Similarly a current of electricity will flow from one point to another if there is a difference of potential between the points, and if a path is provided. The path must be some form of electrical conductor, such as a wire or other means of completing the circuit. Thus, we may compare the flow of electricity to the flow of water, being careful, however, not to draw the analogy too closely, because, in the case of the flow of electricity, there is no actual transfer of matter, while there is in the case of the flow of water.

Current

The strength of current is the quantity of electricity that passes a given point in the circuit in a given unit of time. The unit for measurement is the *ampere,* which would correspond to the delivery of water in cubic feet per second.

In electrical calculations it is customary to let the letter I represent the current in amperes.

Electromotive Force

The electromotive force is that force which tends to cause a current to flow. The flow of water is due to a difference of pressure or "head," as it is called. The flow of the electric current also is due to a difference of pressure, or, as it is termed, a "difference of potential." In the case of water, the pressure is measured in pounds per square inch.

Electromotive force, or, as it is frequently written, E. M. F., is measured in *volts,* and the electromotive force in volts is generally represented by the letter E.

Resistance

To some extent all substances resist the flow of electricity. Metals offer less resistance than do other materials. If a stream of water flows through a pipe, it will meet with a certain resistance due to friction. When a current of electricity flows through a wire, it meets with a certain resistance to its flow, depending upon various factors, such as the material of which the wire is composed, its dimensions, etc.

Resistance is measured in *ohms,* and the resistance in ohms is represented by the letter R.

Ohm's Law

There is a certain relation among these three quantities—current, electromotive force, resistance—which must be kept in mind when making electrical calculations. This relation may be expressed thus:

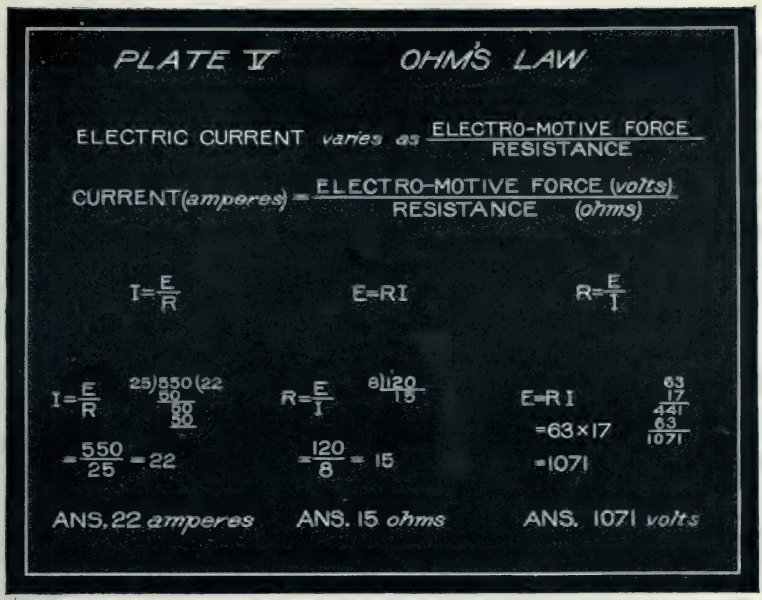
$$\text{Current varies as } \frac{\text{Electromotive Force}}{\text{Resistance}}.$$

Or,

$$\left.\begin{matrix}\text{Current}\\(\text{amperes})\end{matrix}\right\} = \frac{\text{Electromotive Force (volts)}}{\text{Resistance (ohms)}}.$$

Using the letters mentioned above, we have:

$$I = \frac{E}{R}.$$



This expression may be written in the three convenient forms:

$$I=\frac{E}{R} \qquad E=RI \qquad R=\frac{E}{I}$$

In case any two of the quantities are given, the third can readily be found. For instance, if we know the strength of current and the electromotive force, the resistance is found by using the third expression.

Examples

1. The difference of potential in a given circuit is 550 volts; the resistance is 25 ohms. What is the strength of current?

The first expression should be used:

$$I=\frac{E}{R}=\frac{550}{25}=22 \text{ amperes.}$$

2. A current of eight amperes is required. If the electromotive force is 120 volts, what resistance must be placed in the circuit?

For this problem, the third formula is the most convenient:

$$R=\frac{E}{I}=\frac{120}{8}=15 \text{ ohms.}$$

3. What voltage is necessary to make 17 amperes flow through the circuit if the resistance is 63 ohms?

Use the second expression:

$$E=RI=63\times17=1{,}071 \text{ volts.}$$

A Chance for an Inventor

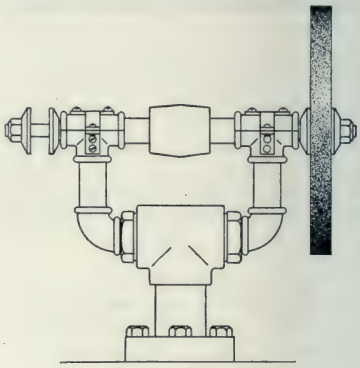
MEXICAN CAPITALISTS are on the lookout for a man who can invent some process or machinery for making soap from the castor bean. This plant grows extensively in Mexico, and a fortune awaits the man capable of utilizing the bean for this purpose. Some time ago the owner of a plantation spent a small fortune in machinery for the double purpose of extracting the oil from the castor bean and for the manufacture of soap. The attempt, as far as the soap was concerned, failed. The market for such a product is unlimited, and the company that first secures control of a successful process is certain of large returns.

Electricity on the Farm

FARMERS THROUGHOUT THE UNITED STATES, especially in regions traversed by swift-flowing streams, are beginning to realize that close to their doors is an opportunity to apply electricity to the work on the farm. The old dams along neglected waterways which years ago supplied the small mills with power, are now being rebuilt, and the old mill-races have been dredged and cleared of rubbish. Each dam and race may yield several horse-power; and the generating plants, poles, wires, etc., are simple and inexpensive. A few years ago farmers worrying along with a score of kerosene lamps and lanterns, now light their houses, barns, and barnyards with electricity, and use the same power to pump water for house and stock. It will not be many months before capital enters this field, and soon the lines of power companies, stretching along the most remote regions, will place these twentieth century "genii" at the service of thousands of farmers.

Grinder Frame

THE ACCOMPANYING SKETCH shows a method of making a grinder frame from pipe and pipe fittings. The base is a heavy flange; the bearings are



GRINDER FRAME

tees, which are split lengthwise and held together by saddles. The rest is of 2-inch and 1-inch pipe. The shaft is put in place and then babbitted. The shaft bearing is made a trifle smaller than the central portion of the shaft, so that the shoulder may prevent side play. The rings just outside the bearings are shrunk on. The proportions may be varied to suit the work to be done.—PERKINS.

A 60-Cent Burglar Alarm

THE FOLLOWING is a description of a simple but effective window burglar alarm which can be put up by anyone and at a very slight expense. The essential parts are a battery, an electric

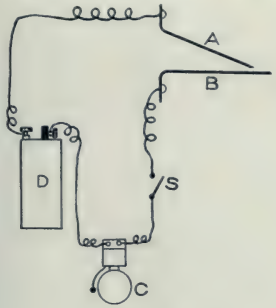


FIG. 1.

bell, two pieces of spring brass, and a few feet of insulated wire.

The arrangement of these pieces of apparatus is shown diagrammatically in Fig. 1. D is an ordinary dry cell, which can be purchased at an electrical supply store for 25 cents. C is an electric bell, which can be purchased for 25 cents; while the other accessories should not cost over 10 cents, making a total of 60 cents. It is also convenient to include a switch S, for opening the circuit when it is desired to throw the alarm out of service, although this is not an essential

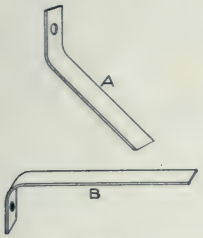


FIG. 2.

part of the alarm. A and B are two contact clips made of the spring brass, and are shown in perspective in Fig. 2. They should be about ½ inch wide and 1-16 inch thick. A should be about 3 inches long, and bent at an obtuse angle as shown; while B should be about 3½ inches long, and bent at a right angle. The exact dimensions are immaterial. A switch may be made from a straight piece of spring brass, pivoted at one end on a screw, and arranged to rest upon the head of a screw at the other, when closed.

When the switch S is closed (Fig. 1), the only break in the circuit is between the tips of A and B; and if these are allowed to touch each other, it is evident that the circuit will be completed through the battery and bell, and the bell will ring. When the window is down, the clips are held apart; and when it is raised even a very slight amount, the clips spring together and close the circuit.

The arrangement of these contact clips in relation to the window is illustrated

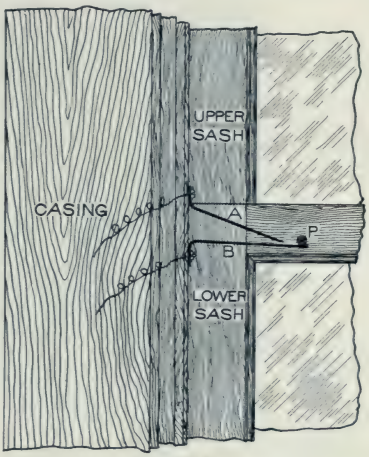


FIG. 3.

in Fig. 3. They are both screwed to the casing as shown, just at the height of the top of the lower sash. When the window is raised, the clips are so adjusted that they will be in contact; but when the window is closed, the pin P presses on the end of B sufficiently to separate them. The distance between the ends of the clips when the window is closed, may be about ⅛ inch.

The arrangement shown is for one window only, but it may be extended if desired to any number of windows, using the same battery and bell, by having a pair of contact clips for each window

connected in multiple with the pair shown in Fig. 1; that is, all the clips A, A, A, etc., should be electrically interconnected with one wire; and all the clips B, B, B, etc., should be electrically interconnected with another wire. The details can be worked out to suit any particular case, and an opportunity is offered for the exercise of individual ingenuity in each particular instance.

A New Testing Set

MESSRS. MACHADO & ROLLER, the selling agents of the Whitney Electrical Instrument Company, are marketing a new form of testing set, illustrated in Figs. 1 and 2 herewith.

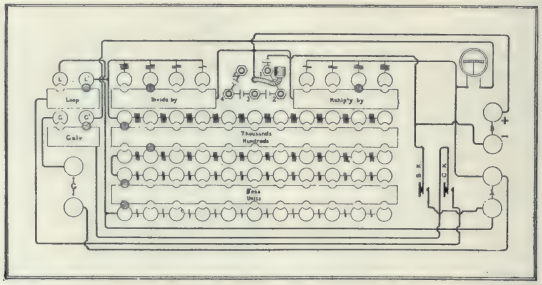


FIG. 1. CONNECTIONS OF TESTING SET.

This testing set is of the decade pattern, in which the drawbacks incident to the great number of plugs necessitated by the old postoffice form of construction are eliminated, there being but four plugs in the rheostat itself. It will be noticed that the use of reversing blocks in the bridge arms has been done away with by adding an extra coil to each arm. This expedient eliminates two plugs, and makes the operation of the set much easier to understand. The keys are of a novel form which can be operated independently, or similarly to the conventional combination key, whichever way may be desired. Five large dry cells are built into the containing case, and a flexible cord with plug is arranged so that any number of cells can be used.

An ingenious modification of the ordinary construction of decade and postoffice sets, is used to shift the internal connections from those employed in making ordinary resistance measurements and the Murray tests, to the connections required for the Varley tests, so that the two X posts common to every bridge are the ones to which the outside line is always attached, no matter what test is being made thereon. A pair of binding-posts, to which an external galvanometer of the reflecting form may be attached for high sensibility work, is also provided; and, by shifting one plug, either this external galvanometer or the one that is built into the set is brought into play. Another pair of posts allows the use of an external source of E. M. F. where this is desired.

Instead of following the conventional procedure of marking the ratio arm blocks "A" and "B," they are stamped "Divide by" and "Multiply by," respectively. The connections are such that, when a plug is inserted from the gap between the "Divide by" block and any one of the four circular blocks opposite thereto, the readings as indicated by the position of the plugs in the rheostat are to be divided by the number stamped on the circular block, to get the correct reading. Similarly, the resistance plugged in the rheostat is to be multiplied by the number indicated by the position of the plug in the "Multiply by" ratio arm block. The plug blocks for changing over the loop and galvanometer connections, are marked with similar clearness, so that practically anyone can use the bridge without chance of confusion. The actual diagram of connections is as shown by Fig. 1.

An accuracy of adjustment of a tenth of one per cent throughout, is claimed; and it is also asserted that the galvanometer is sufficiently sensitive to give a marked deflection with a tenth of one per cent resistance variation, when working with full battery power on a resistance of moderate value. The galvanometer is not affected by external fields, and can be used with the set in any position. It is thought that a moderate-priced set having the above characteristics will meet with considerable favor from a large class of users.

TESTING SET.

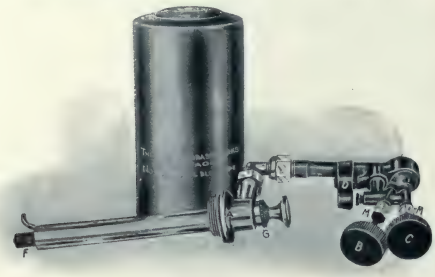
Where Science Pays

NEARLY FOUR-FIFTHS of all the dyes consumed in the world are made in Germany. This is simply another illustration of the immense value of science to business. Germany is by no means particularly adapted by nature for the building up of great chemical industries. The many chemical products made in Germany are mainly the result of the foresight and wisdom with which the German nation has fostered scientific investigation. Science has paid Germany handsomely for all she has done for it.

The Intelligence of the Shad

THOSE OF US who have been possessed with the idea that fish are the least intelligent of all living creatures have something to learn. Shad taken from the Connecticut River by the United States Fish Commission, are carried to the Washington hatchery. There the eggs of the female are fertilized and hatched. After serving man by the egg supply, the females are tagged with a platinum label fastened to the dorsal fin,

and liberated in Potomac waters. Often these same shad are taken again in the Connecticut River catch of the following year. The same shad has been caught three times in the Connecticut, twice having made the journey down the Potomac,



into the Atlantic Ocean, probably thence through Long Island Sound, into the Connecticut, and so up to the spawning ground again.

The homing pigeon and the seals on Lukannon beach do not excel in kind this instinct for locality, this wonderful, inexplicable ability to get back home.

A New Lead-Burning Blowpipe

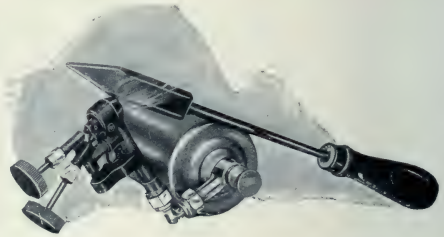
THE ACCOMPANYING CUTS represent an interesting appliance capable of accomplishing many kinds of work that require the intense heat and peculiar

quality of flame produced by the oxy-hydrogen blowpipe. The results obtained from this blowpipe go to prove that the maximum degree of efficiency is produced by mixing exactly the proportionate amount of air with the fuel required for absolutely perfect combustion.

In the Turner double-jet alcohol blowpipe here described, which is manufactured by the Turner Brass Works, Chi-

cago, Ill., the control of the air and gas is secured by means of the two valves; and the mixture is burned in the combustion chamber of the burner, resulting in a temperature of over 3,000 degrees.

This blowpipe will do a job of lead burning equal to that done by the expensive and cumbersome oxy-hydrogen generator, which appliance, up to the present time, has been the only satisfactory means for doing that work. The art of lead burning consists in joining together



two or more pieces of lead into one mass, without the use of either solder or flux, in doing which the flame of the blowpipe is applied to the joints to be burned, causing the metal to flow, and to form a joint as strong and perfect as any part of the lead structure. The terminals of the lead

storage batteries have to be joined in this manner, and the seams of the lead sheets for lining the acid chambers and lead-lined tanks, are burned, not soldered.

Every owner of a lead storage battery will now be able, when supplied with this new device, to do his own lead burning; and it is no longer necessary to secure the services of a professional lead burner, and pay the high charges for shipping the hydrogen generator several miles, perhaps, for the purpose of installing a battery, or to make small repairs, the actual work of which requires but a few minutes' time.

This blowpipe is also very desirable for laboratory and experimental work, as the burner has a range of adjustment from a reducing to a slightly oxidizing flame. The burner is swiveled so that the flame can be turned in any direction, changing it from a blowpipe to a Bunsen burner, as desired. The intensely hot, clean, needle-pointed flame, the ease with which it can be generated and adjusted, and the compact form of the appliance, combine to make it invaluable to the lead burner, electrician, and general mechanic, as well as the artisan and student.

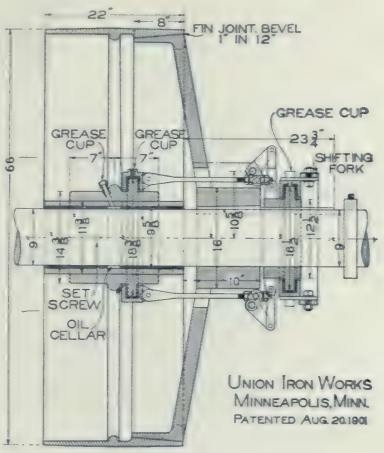
The heat produced by the double-jet alcohol blowpipe is more than is ordinarily required by jewelers and opticians for their work. It is sufficient to flow 25 per cent platinum solder; and the needle-pointed flame is especially suited to fine soldering, and such work as is ordinarily done by the mouth blowpipe, as the intense heat is confined to the point to be soldered without affecting the surrounding surfaces.

This double-jet blowpipe is an improvement over other appliances now in general use, as a continuous blast flame is maintained at all times, and neither foot bellows nor mouth blowpipe are required. The pressure of air in the reservoir, forced into it by the pump, is sufficient to last several hours. The blowpipe will hold ¾ pint wood alcohol, which will last about three hours when the blowpipe is burning at full blast. When desired, air blast can be turned off entirely, and the blowpipe left standing with a small flame, ready for immediate use. The flame is perfectly clean, and, when applied to the metal, will not blacken the surface or leave an oxide or scale.

The weight of the appliance unpacked is about one pound, and the adjustable feature of the burner makes it so compact that it can be carried in the pocket or tool bag.

Friction-Cone Clutch Pulley

IN THE USUAL FORMS of friction-cone couplings, there are several disadvantages. Among these may be mentioned the end thrust due to the horizontal component of the pressure between the conical surfaces. To overcome these objections, the Union Iron Works have introduced a clutch. It is claimed to be self-centering, perfectly balanced, and free from labor on the thrust collar except at the moment of engaging or disengaging. The cones are well lubricated by three compression oil-cups on the inner side of the shifting member. These oil cups are not shown in the accompanying illustration.



Street Cleaning and Consumption

CHICAGO is about to begin a thorough crusade against dirty streets in the down-town districts. This brings to mind the statement recently made, that from one-fifth to one-third of those employed in street cleaning in New York City contract tuberculosis. But in Berlin

the men who do that kind of work are said to be less subject to pulmonary diseases than are other classes of laborers.

The only explanation seems to be that in Berlin the streets are always sprinkled before they are swept, and in New York they are not. Dust carries with it the germs of many diseases, and especially of consumption. Men working in the midst of that dust and inhaling it continually, run extra risks. When laborers are sweeping up the dust with their brooms, pedestrians who happen to take notice can get out of the clouds of dirt they raise; but the men themselves have to stay in it.

The Health Commissioner of New York City is said to recommend not only the sprinkling of the streets before sweeping them, but also the addition of some cheap germicide to the water used for the purpose. That will kill off the germs adhering to particles of dirt which are not removed, and will contribute materially to the preservation of the public health.

Young Lochinvar Up-to-Date

When young Lochinvar rode out from the West,
He claimed that his automobile was the best;
It was painted dark red, and it brilliantly shone.
He went like a streak, and he rode all alone;
He shot over ruts with a zipp and a jar,
And people fled madly from young Lochinvar.

With a whirr of his wheels and a hum of his cogs,
He knocked down the children and ran over dogs;
He frightened the horses and laughed at their pranks,
And men who got angry he looked on as cranks;
He gave her the very last notch on the bar,
And a cloud of dust followed the gay Lochinvar.

He stayed not at bridges, he stopped not for stone,
He calmly took all of the road as his own,
Till he came to a crossing and smashed through a gate
And endeavored to butt through a trainload of freight—
They searched, and, at last, lying under a car,
They found a few chunks of the bold Lochinvar.

The lady sat waiting to hear the loud hum
That would tell her the gallant had finally come.
But she waited with sighs and she waited in vain—
Those car wheels bore many a sickening stain.
And, to show you how pitiless some people are,
They said it was good for the young Lochinvar.

How to Make a Hall-Stand

By J. H. WOOLFITT

ONCE UPON A TIME it was the proud boast of an Englishman that his house was his castle, but nowadays the individual seeking to realize the like idea becomes the tenant of a dwelling all "his own," only to find that the hall of his castle is barely large enough to contain a doormat, and that he has only wall-space there to utilize as a small family portrait gallery.

It is a more satisfactory state of things, however, if the entrance hall of one's house affords ample floor-space, and there is scope for a man of taste to decorate and furnish that foremost and important portion of the interior of his habitation in a way that will evoke the admiration of his friends. Meanwhile, as we are giving to our subject proper and due consideration, we are encouraged to hope further that this hall-way is paved with tiling or tesselation; or, if that be expecting too much, we can modify our ambition to a degree nearer to the bounds of possibility, and shall content our Sybaritic aspirations with parquetry, a floor-treatment that demands only a little skill and labor. If neither of these methods of hall-paving be attainable, we must of necessity settle down to matter-of-fact oilcloth, our choice to be as costly in quality as we can afford, but tasteful withal, to serve as covering to the sometimes new but frequently uneven and weather-worn, floor-boards.

En passant, we have referred to the condition and area of the floor of the hall, and thus we arrive at the subject of our article, how to make a hall-stand, a fitment which undoubtedly is the most important item of furniture the hall should contain; and if this be arranged to hold decorously walking-sticks and umbrellas, and be fitted also with racks for hats and hooks for garment suspension, it will be acceptable as a substitute for, and may perhaps depose forever, the unhandsome row of pegs, and the decorated drain-pipe will be relegated to its own place.

The skeleton framing which, *de rigueur*, we find the accepted form of hall-stand, is all very well in its way, but it must be confessed that little taste pervades the design—in fact, we have one now in our mind's eye wherein the maker apparently strove to fashion his mahogany to the semblance of a tree, insomuch that the hat-pegs gave one an impression of small branches growing upon larger ones, which in turn were attached to, as though growing from, the main post or parent stem, and, needless to say, this disposition of material resulted in great waste of space—but the assertive pegs were very useful in accentuating the antiquity of hats and the dilapidation of old clothing.

By reason of location, and a consequent heavy "wear-and-tear" to which hall furniture is liable, we must advocate the employment of wood of good quality in the construction of our stand, and one that will render it capable of resisting hard usage; and to that end we shall select pitch pine, being assured that it will prove to be an efficient material. Pitch pine is obtainable in workable substance for our requirements—namely, in 12-inch boards or wider—and at some timber-yards the narrow and thinner boards suitable for the slip-feathered match-boarding can be obtained grooved in readiness to use. It is a wood that effectively renders bold detail; and as it bears a grain that no one in possession of a clear artistic conscience will treat otherwise than naturally, we shall determine to finish with a clear varnish in order to develop the beautiful figure of the dressed and planed board. In recognition of the capabilities of pitch pine, we see it extensively used in situations and for purposes where endurance is demanded, and in church and school furnishing one must agree that it meets a test always pretty severe.

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The depth from front to back of the fitment we are about to make must not be too assertive, for the reason to which we have already drawn attention, namely, that the furniture in the foremost apartment of a dwelling meets with rougher handling than that in the remainder; and we may take it that nearly every caller, dirty boots included, is asked to "walk inside," but only privileged familiars are invited to the sacred penetralia. Incidentally, we remember also that luggage bearing the dust, and sometimes mud, of travel, is deposited there, for a period at least, and much of the miscellaneous business connected with household matters is transacted at the entrance. We shall also avoid the setting-up of a structure excessively tall and unstable, and therefore decide upon dimensions as follows: Sides, 6 ft. 5 in. high, and 12 in. wide; these sides will be connected by top-board and shelves, so that in elevation the fitment is 2 ft. 6 in. wide at top, and is splayed at bottom to 3 ft. in width. Needless to say, this departure from right angles contributes to stability, which with parallel sides would be rendered doubtful.

The construction is proceeded with as we get out the two sides, duly squared and planed from boards selected with bold markings, particularly observing the latter prevision, because the wood will bear no other ornament than that with which nature has endowed it, if we may except the apertures which make the two feet upon each side, and the brackets and rails; but we must not forget that grooves will be wanted on the inner surface wherein to house the bottom-board and the shelf, and these grooves must stop at 1 in. from the front edge, an arrangement which is workmanlike, and conceals the joints where the two shelves are put in their places. The elevation (Fig. 1) is drawn to scale, and the dimensions there set out will serve as a guide to, and will facilitate, the erec-

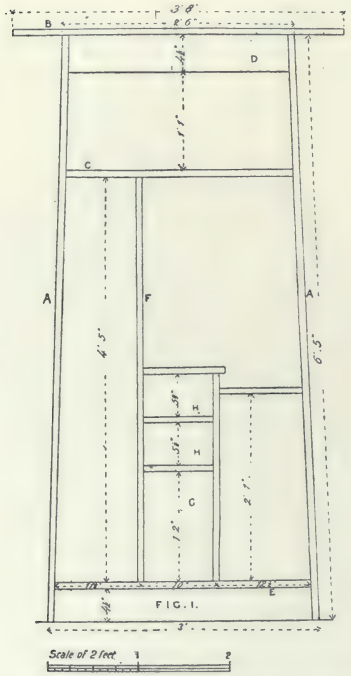


FIG. 1.

tion. These prepared sides (A A) are then set up upon a level floor, and distanced apart, splayed at the angle fixed by the measurements, which will insure the desired stability. They can be preserved in position, temporarily, by laths at back and front, crossed and nailed by small wire-nails, the laths to be ultimately removed, and the consequent holes filled with colored plaster. Further, before setting up the two boards thus, their two end-edges will require beveling to an angle—at top, to allow of close contact with the top-board; and at bottom, to allow the fitment to rest firmly upon the hall floor.

Whilst the sides are fixed in position and held by the laths, the top-board (B), which we presuppose has been prepared, may be screwed in place; and the preparation of this top-board calls for no particular remark, saving that it should bear a neat edge, and must not be "in winding," a contingency to which all large surfaces of wood are liable, but which vagary may be corrected by damping the concave side and leaving for a night under weights sufficient to reverse the conditions. In size, the top will be 3 ft. 8 in. long and 14 in. wide, and, when fixed upon the sides, will project 2 in. over the front and be flush at the back.

The situation of the shelf (C) is 1 ft. 5 in. from the top; it is housed in grooves cut in the sides, and secured with good glue; in width it will be sufficient to reach from flush with the front to within ½ in. from the back, to allow for the matching which will cover up and form the back.

The cornice piece (D) will require a certain amount of preparation in tongues cut upon the ends, to be inserted in channels of proper size run a certain distance upon the sides; and the place for these channels will be so that the front edges of sides and front of cornice piece will be one level surface, and perfectly flush when put together.

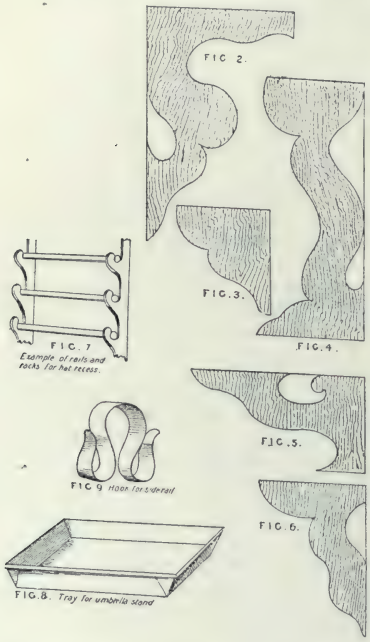
The shelf (E) at bottom, which forms the floor of the fitment, can now be inserted in its grooves; and this, besides being secured by glue, will derive a greater element of strength from a couple of screws to each side, driven transversely from below, through the shelf and into the sides. The next part to fix is the upright partition (F), which divides the space between the shelf and bottom board. It is only an inch-board of proper length and width, and should fit easily in place, where it may be secured by screws driven above and below. The idea is that the small recess resulting shall be a receptacle for hats, and to that end the interior is to be fitted with racks of thin wood and rails, as shown in Fig. 7. The front of the recess is shown in the perspective view covered by drapery (so dear to the feminine notions) of some diaphanous material, but which is sufficiently dense to exclude dust.

We next have to make the cupboard (G) and two drawers (H H), and it will be seen that the partition and bottom-board will form two sides of the case for these; the other side and top are not difficult to fix, and are simply screwed together: there are, however, certain concealed housings to be cut to receive the drawer runners, which will in turn be cut back to allow the housings to be driven closely home. The drawers can be made by no easier method than nailing together. Their fronts are 1-in. pitch pine, but their sides, bottoms, and back ends may be of ½-in. deal. The sides are nailed to recesses or laps cut in the ends of the front; the back end is driven into grooves in the drawer sides, and the bottoms are nailed on. To call this method rough carpentry may be true in theory, but need not be so in fact, if the job be neatly done. With regard to the cupboard door, it will pay for the extra trouble taken if made as a mortised frame with panel. Mortising is more satisfactory than halving, if we consider the results obtained in good appearance and finish.

There are, next, the fittings of the space for holding umbrellas and walking-sticks to consider, and they will consist of a mortised frame neatly fitted with a cross-bar, making two apertures for the top; the crossed bar may be mortised to the frame. If the apertures be protected by a casing of tin, it will be a great advantage. We shall also have to make a tin tray (Fig. 8) for the bottom of this umbrella-stand; but that can be done by bending up a rim upon a sheet of tin of proper size, and by pinching the corners, and bending them back upon the rim.

The edges of the rim should be strengthened by rolling them upon and enclosing a frame of stout wire, and finished with solder.

There now remain the brackets (Figs. 2 to 6) to be affixed in the places where



they appear in the drawing; they should be of ¾-in. stuff, and cut out by the turning saw. The two on either side under the overhang of the roof, support the rails that are let into circular holes in each pair of brackets; and the brackets are doweled upon the sides, and also held by screws driven down through the top-board into them.

The hooks (Fig. 9) for these outside rails are sawn and filed up out of moderately stout brass plate, and are bent to shape to embrace the rail, so that they will not easily become detached when they are used for garment suspension.

All the brackets and bits of scroll-work may be cut from ¾-in. wood by the scroll-saw in the manner we have just described; the method of fixing each piece will be by doweling also.

The back is made up of the narrow matched boards, V-jointed, and tongued by thin slips of wood, cut with the grain at right angles. It should, when fixed, lie level with the top-board and sides, all the other boards and partitions having been cut so much less in width to allow for this. Use panel-pins to affix the back.

We are now so near the completion of our work that the varnishing only remains, and it will be as well to prepare the surface first by giving it a coat of size. When that is dry, pale oak-varnish may be applied; and we venture to predict that we shall be pleased with the appearance that our fitment presents when placed in position against the wall of our hall, and that the purpose of every nook, cupboard, and drawer, will be revealed and appreciated when occasion for the employment of each part arrives.

Hope

THOUGH to-day may not fulfill
All thy hopes, have patience still;
For, perchance, to-morrow's sun
Sees thy happier days begun.

Governors

A Description of the Two Principal Types of Speed Regulators for Steam Engines

By H. A. DREFFEIN

Instructor in Mechanical Engineering, American School of Correspondence

THE LOAD ON AN ENGINE is never constant, although there are cases where it is nearly uniform. While the engine is running at constant speed, the resistance at the fly-wheel rim is equal to the work done by the steam. If the load on the engine is wholly or partially removed, and the supply of steam continues undiminished, the force exerted by the steam will be in excess of the resistance. This excess will accelerate the speed of the engine, and the engine will "race," as it is called. Also, if the load increases and the steam supply remains constant, the engine will "slow down."

It is evident, then, that if the speed is to be kept constant, some means must be provided to regulate the supply of steam so that it shall at all times be exactly proportional to the load. This is accomplished by means of a governor.

Kinds of Governors

Steam-engine governors act in one of two ways:—they may regulate the *pressure* of steam admitted to the steam chest, or they may adjust the speed by altering the *amount* of steam admitted. Those which act in the first way are called "throttling" governors, because they throttle the steam in the main steam pipe. Those of the latter class are called "automatic cut-off" governors, since they automatically regulate the cut-off.

In most governors, centrifugal force, counteracted by some other force, is employed. A pair of heavy masses (usually iron balls or weights) are made to revolve about a spindle, which is driven by the engine. When the speed increases, centrifugal force increases, and the balls tend to fly outward; that is, they revolve in a larger circle. The controlling force, which is usually gravity or the action of springs, is no longer able to keep the balls in their former path. When, therefore, the increase is sufficiently great, the balls in moving outward act on the regulator,

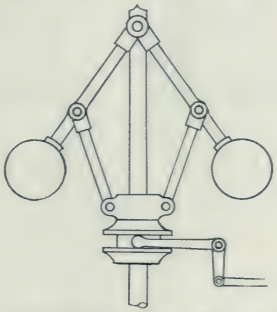


Diagram of Early Form of Governor.

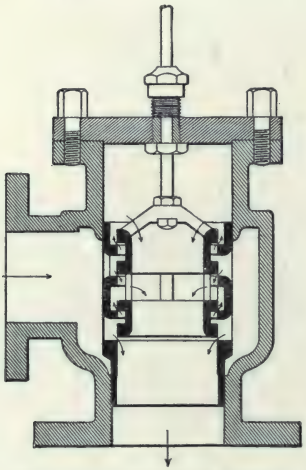
which may throttle the steam or cause cut-off to occur earlier.

With the throttling governor, a balanced throttle valve is placed in the main steam pipe leading to the valve chest. If the engine runs faster than the desired speed, the balls are forced to revolve at a higher speed. The increase in centrifugal force will cause them to revolve in a larger circle and in a higher plane. By means of some mechanism (levers and gears) the spindle may be forced downward, thus partially closing the valve. The engine, therefore, takes steam at a lower pressure, and, the power supplied being less, the speed falls slightly.

Similarly, if the load is increased, the engine slows down, which causes the

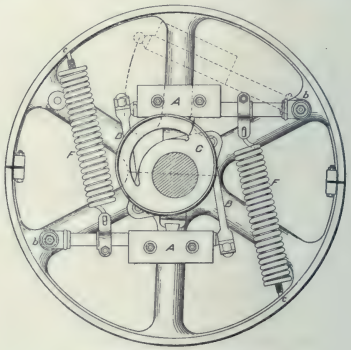
balls to drop and open the valve more widely; steam at higher pressure is then admitted, and the speed is increased to the regular number of revolutions.

With the Corliss or the Wheelock engine, the governor of this type acts differently. Instead of throttling the steam in the steam pipe, the governor is connected to the releasing gear by rods. An increase of speed causes the releasing gear to unhook the disengaging link earlier in the stroke. This causes earlier cut-off, which of course decreases the power and the speed, since the amount of steam admitted is less. If for any reason the load increases, the governor causes the valves to be held open longer. The cut-off, therefore, occurs later in the stroke.

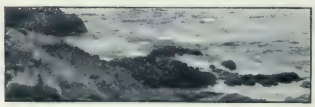


Valve and Seat of Waters Governor.

Governors for changing the point of cut-off are used on slide-valve as well as on Corliss engines. Slide-valve engines, regulated in this way, are called "automatic cut-off" engines. For such engines, a shaft governor is used which consists of two pivoted masses or weights arranged symmetrically on opposite sides of the shaft, attached to springs which tend to hold them in their innermost position. These weights are connected to the eccentric; and, as the engine speeds up, the weights move outward, changing the position of the eccentric and therefore the point of cut-off of the engine. These governors are so designed that as the engine speeds up, the cut-off is made earlier, and later as it slows down, the earliest cut-off being zero, and the latest about 5/8 of the stroke.



Buckeye Engine Governor.
Regulation by Change of Angular Advance.

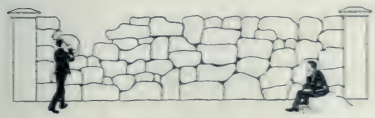


Noon Hour Talks

Every Noble Work is at First Impossible

A SUCCESSFUL RAILROAD PRESIDENT was once asked by a young man, "What is the secret of success?" "My Boy," he said, "there is no secret, it is just *dig, dig, dig.*" In all likelihood this was not the answer the young man anticipated. He expected to hear of some "get-rich-quick" scheme that meant neither time nor energy.

Last year a young man made application to enter a certain Western college, and, in talking over the studies with the Dean, asked if there were no shorter way to get through and graduate than the course prescribed. "That depends entirely on what you want to be," replied the Dean. "When God wants to make an oak, he takes fifty years; but when he wants to make a squash, he takes six weeks." What a lot of squashes we find in every trade and profession—half-baked, underdone people who seldom succeed, because they refuse to give the time and thought to equip the brain and hand with the training the world is always ready to pay for.



Of course, difficulties, sickness, and care of one kind or another enter into the lives of all men, placing, as it were, barriers across the path of progress. This is certain to be the lot of the average human being; and yet a trying circumstance is not a sufficient reason for a man to give up the struggle and take a back seat. If such were the case, what would the world be to-day? Take one illustration:—Elihu Burritt was the son of a poor shoemaker. To save money to secure an education, he worked from daylight to dark in a blacksmith shop. Discouragement stalked all around him, but young Burritt persevered and won a place among his country's successful men. Do you wish to live without trial? Then, if your wish is gratified, you will die a squash, an underdone man. Without the struggle, you never know your strength. It is the rough seas that make the skillful sailor. Unless you go "up against" the world, you will never find yourself. Hardship is the native soil of true manhood.

The trouble with most people lies in the fact that they require such favorable conditions before they are able to accomplish anything. To-day the men who succeed are the men who do things with very little. When they have a task to perform, they take what is at hand, and without any further delay settle down to work. You who are an engineer, think of James Watt making the model of his condensing engine out of an old syringe;

or George Stephenson, the coal miner, building his first locomotive in a little outhouse; or Michael Faraday, while a bookbinder's apprentice, experimenting in electricity with old bottles. These men's names are household words throughout two continents; yet they were not "born with silver spoons in their mouths;" they attained their training and success through great personal effort. Few young people to-day face the obstacles these men overcame. They were not content to sit and wait until all the conditions were favorable for their work; they made the conditions favorable by untiring effort.

No success is attained in this day or age without intelligent effort; and the quicker we get this truth into our heads the better, even if it has to be beaten in. What the world wants most is people who "do things." During the Civil War, President Lincoln found many generals who made a splendid appearance on parade, whose showing in the matter of discipline and efficiency was excellent, but they failed to "do things." When ordered from Washington to carry out some movement, the cavalry horses were sick, or the roads were bad, or they did not have enough men; and while they waited for more favorable conditions, the opportunity passed. Lincoln promoted Grant because he could do things—a leader who accepted the conditions as they were, and, without grumbling, made the most of them. It is not the conditions that make a man's success, but the trained skill and perseverance of the man himself. A pan of water and two thermometers were the tools by which Dr. Black discovered latent heat. An eminent foreign scientist once called upon Dr. Wollaston, and requested to be shown over his laboratories, where he had made so many important discoveries. The Doctor took him into his study, and, pointing to an old tea tray on the table containing a few test papers, a small balance, and a blowpipe, said, "There is all the laboratory I have." Had Dr. Black or Dr. Wollaston put off their investigations for more favorable conditions, ten to one we should never have heard of them.

In every phase of business life, what the employer wants is men who are not always growling about poor tools, or lack of room, or better machinery, but men who take the shop, tools, and machinery as they are, and do their best. Such men are seldom out of a job. They are too valuable to their employers.

In battle or business, whatever the game,
In law, or in love, it's ever the same;
In the struggle for power, or scramble for self,
Let this be your motto—Rely on yourself.

In order to receive attention in the columns of THE TECHNICAL WORLD, all inquiries must be addressed to the Consulting Department, and must be accompanied with the *full name and address of the sender.**

Demagnetizer Coil

Question: Please explain how to make and use a demagnetizer coil for watches.—*S. M. B.*

Answer: You have simply to take a piece of wire, wind it up into a coil or solenoid, and pass an alternating current through it. To demagnetize the watch, place it within the coil and gradually withdraw it. You can use a core made up of a bundle of iron wires; but in this case you should be very careful not to get the watch too near, because the strong field might injure its delicate working parts.

Centrifugal Force

Question: Give an explanation of the forces that act upon the rolling hoop, the spinning top, and the gyroscope.—*E. A. J.*

Answer: The force acting on the rolling hoop, if the hoop has constant velocity, is called "centrifugal" force. This force acts directly away from the center. To compute it, use the formula:

$$\text{C. F.} = \frac{\text{Weight} \times (\text{Velocity})^2}{\text{Gravity} \times \text{Radius}}.$$

The spinning top and the gyroscope are similar. No satisfactory explanation of the phenomena can be given without employing higher mathematics. Without this aid, the following is about the best that can be given:

There are two facts to be explained—support, and orbital movement, or traveling about the supporting point. For the first, suppose the disc composed of 1,000 equally heavy particles. When it is set rotating and released, each of these particles is, as a separate ball, acted upon by two moving forces, that giving the rotation, and that of gravity; but the whole is also held together by the constraining action of cohesion. Suppose that, when released, the axis points below the horizontal. Gravity acts in vertical lines and equally on all the particles. Its direction and amount may be represented by equal short pendant threads dropping down from all the particles. If the particles be also supposed in a single plane, the extremities will all lie in a new plane, slightly without and below the plane of the disc, and parallel with it. In giving rotation, the forces impressed upon the several particles of the disc will all point in its plane, being represented at any moment by tangents to the circles in which the several particles move, pointing in all directions, and varying in length from zero at the axis to a maximum at the periphery.

But the resultant movements or ten-

*If W. A. F. will send his name and address, we shall communicate with him. His inquiry regarding a telegraph line was not clearly stated.—THE EDITORS.

CONSULTING DEPARTMENT—(Continued)

dencies of the particles must all terminate in the exact plane in which the gravitative components were seen to terminate. Every particle thus acted upon, then, tends to go outward or forward into the new plane already referred to. The several pressures are to points scattered somewhat widely in that plane; but owing to the cohesion of all the particles, they are constrained to move forward in a body. The effect is as if the whole disc were pulled outward and very slightly downward, while the pivot in the notch reacts or pulls in the opposite direction; and the wheel is supported, in part, as if slung up in strings attached to its two faces and pulled in opposite directions. When the disc is above the horizontal, the new plane is behind or within it; it then pushes against the pivot, and, this reacting, there occurs support by opposite pressures, instead of tractions. Thus we discover one reason why no material support is needed for the remote end of the axis, while, as a consequence of this view, if the axis be horizontal, it must first sink slightly, yet it may be only imperceptibly, before support can occur. This agrees entirely with the results of mathematical analysis.

In the second place, why does the disc travel around the supporting point? When not overpoised, gravitation acting downward, and rotation, in the ascending side of the disc, upward, the latter is in effect decomposed into a horizontal and a vertical component, the horizontal expressing itself in the pressure already referred to, the vertical being resisted or antagonized by the force of gravity, the result for each particle being the sum which the latter as a negative quantity would form with the former. In the ascending side, therefore, gravity overbalances, equals, or diminishes, according to the place of each particle, the rotative force of ascent acting upon it; but to the vertical component of the rotative force of all the particles in the descending side, it adds alike a quantity of action equal to its own amount. Hence the whole rotative force in the descending half may be considered as increased; that in the ascending, as diminished. There will be some point in the ascending half at which the vertical component of rotation equals gravity; this will become in effect a point of rest, or of no action. This is then the point pierced by the resultant axis—the point about which all the particles under the combined forces will tend to revolve, those in the ascending half starting with less radii to sweep around this point as a center, those in the descending starting with longer radii, and sweeping in longer curves about the same point. Thus the disc is continually carried to the side in which the action is most checked, and this constitutes the traveling movement. When overpoised on the opposite side, the action of gravity on the disc itself is upward, the axis acting as a lever, the support on which it rests as a fulcrum; the rotative force of the descending particles is now resisted by it; and for a like reason, the disc now moves toward its descending side. When not overpoised, the traveling movement of the disc itself introduces a new element into the case, by resisting the rotating of particles in the upper half backward in the course of movement. This checks and diminishes the action in the upper half of the disc, and constitutes a new source of support by generating a tendency upward; and it is doubtless this part of the action that raises the disc at times to an erect position. The principles thus arrived at, explain also why the disc travels faster as its axial rotation lessens, and also when weights are added to it; why in the ordinary form it rises if its motion is hastened with the hand; why, if overpoised, it descends by being hastened, and rises on being delayed in its orbital movement. In fact, it may safely be said, these principles explain every phenomenon which the instrument can be made to present. The same explanation, in effect, applies if the rotating body be a sphere or of any other form.

The facts of support and orbital movement, though separately considered, are really but two different expressions of the same phenomenon. The two actions, here for convenience separated, really combine in one movement, and that is the composition of a rotation caused by gravity with another imparted by the hand.

CONSULTING DEPARTMENT—(Continued)

The reason why the rotating body does not fall is that, in such a body, whenever its plane is oblique to the vertical, gravity is no longer allowed to act singly, but must at every instant enter into composition with another force. Hence the body in such case cannot simply fall, but must move toward such new space as the combined actions shall determine; and hence, again, the same force which ordinarily produces a vertical fall, here carries a body round in a horizontal circle, or secondarily sometimes even causes it to ascend. The weight of the rotating disc, however, is in all positions sustained by the support and base on which the apparatus stands. In this explanation, the distance through which the gravitative force acts has been taken as very short, because by experiment it can be proved that, unless the weight of the ring is very great, the whole downward action of gravity on the disc is very slight compared with that of the rotation first imparted by the hand, sometimes as small as in the ratio of 1 to 40 or 60.

Steel Balls

Question: Are steel balls as used in ball bearings made in the same manner as round lead balls?—*F. R. P.*

Answer: No. The steel ball is made usually by turning, while the lead balls are compressed in a bullet-making machine.

Load for Ball Bearings

Question: How can the load which a single ball can stand be calculated, and what factor of safety should be used?—*F. R. P.*

Answer: The speed at which the bearing revolves in connection with the weight upon the same, must always be taken into account. As the crushing point of various sizes of steel balls varies when a "dead load" is on it, and when the bearings are in motion, no formulas have been found which will fulfill all conditions, and therefore the only method would be to make an actual test. Manufacturers determine allowable loads from tables which have been compiled from tests.

Overshot Wheel

Question: Will you please tell how to build an overshot water wheel for a stream delivering 50 cubic feet of water per second at a 20-foot fall?—*M. R. H.*

Answer: A wheel of large diameter would be preferable if conditions admit it. The sluiceway, to deliver 50 cubic feet of water per second, should be about 2 feet deep and 3 feet wide. This would give you a velocity of about 8 1-3 feet per second. The water is received into cavities formed by stout planks extending between the sides of the wheel, and placed at an angle or curved toward the stream. These are buckets proper, and the wheels are sometimes called bucket-wheels. The chief causes of loss of head are: first, the relative velocity of the water when it enters the wheel; and second, the velocity which it possesses at the moment it falls to the level of the tail-race. Such wheels answer well for heads of from 13 to 20 feet. For heads of less than 10 feet, breast wheels are preferred. The velocity of buckets should not be less than 3 feet per second; it may be 6½ feet per second for small wheels, and 10 feet for larger wheels, without sensibly affecting the efficiency. The efficiency at a low speed may rise to 80 per cent; but ordinarily, with velocities of from 3 to 6½ feet, the efficiency varies from 70 to 75 per cent. The capacity of the buckets should be three times the volume of the charge of water; they may be 10 or 11 inches deep, and be placed 12 or 14 inches apart.

Vibrating Substances

Question 1: What is the composition of shoemaker's wax?

Question 2: What is the best known substance susceptible to sound waves, that is, to cause it to vibrate, as the transmitter in a telephone?—*G. M.*

Answer 1: As in all trades, we do not know that there is a fixed practice as to the quality of the wax used. Commonly yellow pitch is used.

Answer 2: Membranes are eminently fitted for taking up the vibration of the air, on account of their small mass, large

CONSULTING DEPARTMENT—(Continued)

surface, and readiness with which they subdivide. Gold-beater's skin is probably one of the best. In common practice with the telephone, however, aluminum and wrought-iron diaphragms are found to give the best results.

Polyphase Currents

Question: Please tell me what is meant by one-phase, two-phase, and three-phase currents. —*H. W. B.*

Answer: These are terms used in alternating-current work. A single-phase current consists of a single current which is supposed to flow first in one direction, then in another. The curve of such a current is shown in Fig. 1. Such a current would be produced during one revolution of a simple coil in a uniform bipolar field.

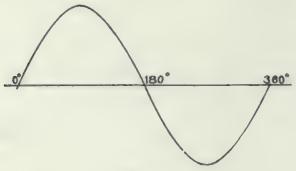


FIG. 1.

A two-phase current consists of two single-phase currents at 90° from one another, as shown by Fig. 2. Such currents would be produced by two single-phase armatures connected on the same shaft and in the same field, the winding on one being displaced 90° from that of the other; or by two coils on the same core 90° apart.

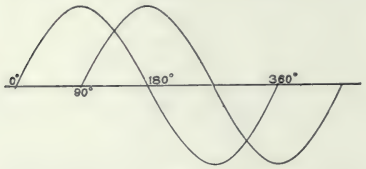


FIG. 2.

A three-phase current consists of three single-phase currents 120° apart, as shown in Fig. 3. Such currents would be produced by three armatures mounted on the same shaft and revolving in the same field, if the windings on each were displaced 120° from those on the others; or the same would be obtained by placing three coils on the same core 120° apart, and rotating them in a bipolar field.

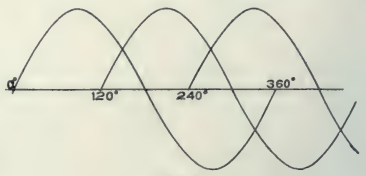


FIG. 3.

Sulphur Dioxide Gas

Question: Explain a simple method of making sulphur dioxide gas.

Answer: Heat sulphuric acid with copper, charcoal, or sulphur.

Question: How is lead mixed with iron?

Answer: Lead does not form a compound with iron. At high temperatures, it vaporizes. Perhaps you are thinking of lead sulphide. If this is in contact with heated iron, the sulphur will unite with the iron, forming iron sulphide; and the lead will be set free.

Question: What is a good cement that will not crack on hot iron?—*J. B. F.*

Answer: Natural hydraulic cement should not be used. You should make a mortar by using hard-burned furnace cinders—one part Portland cement, two parts sand, and five parts cinders.

H. P. of Tandem Engine

Question: Will you give me some rules for calculating the H. P. of a tandem-cylinder steam engine?—*F. J.*

Answer: The rule for calculating the indicated H. P. of a tandem-cylinder engine, involves the same principles as in the case of an ordinary simple engine. We must, however, compute the power developed in each cylinder separately, and

then add the two. This can be combined in one formula, as follows:

$$\text{I. H. P.} = \frac{L \times N\ (PA + P'A')}{33{,}000}.$$

In this formula, L equals the length of the stroke in feet; N equals the number of single strokes per minute (twice the number of revolutions per minute); P equals the mean effective pressure of the high-pressure cylinder; A equals the area of the piston of the high-pressure cylinder, with deduction for the area of its piston rod; P′ equals the mean effective pressure of the low-pressure cylinder. A′ equals the area of the low-pressure piston, with deduction for the piston rod.

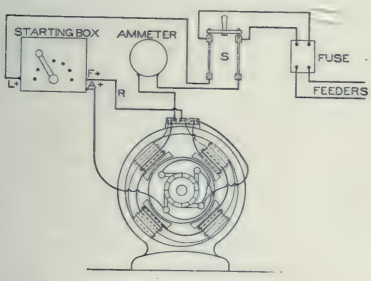
A convenient rule for quickly finding the power of any engine, the tandem-cylinder included, is to square the diameter of the low-pressure cylinder, and divide by 2. The diameter being given in inches, the answer will be in H. P. At the best, however, this rule is only approximate.

Wiring Connections for Motor

Question 1: Are the connections correct in the accompanying sketch?

Question 2: Explain the marks on the starting box; L+, A+, F+.

Question 3: In what place could I put a rheostat on this motor?—*A. B. R.*



Answer 1: The connections shown are correct for a compound motor.

Answer 2: The letters stand for positive side of the line; positive side of the armature; and positive side of the field.

Answer 3: The rheostat could be placed anywhere in the shunt-field circuit of the motor, a good location being that marked R in the sketch.

Setting Valves on a Locomotive

Question: Please give me an explanation of the method of setting valves on a locomotive engine.—*P. E. P.*

Answer: This is a comparatively simple operation, but one requiring some care. In the first place it may be stated that no link motion can be arranged to give equal cut-off at all points for both strokes of the piston. The most satisfactory arrangement is one that provides for an equalization of the lead and cut-off at mid-gear, which will cause a variation of cut-off of from ½ to ⅜ of one per cent in the full gear point of cut-off and at other points, this being due to the slip of the link block, angularity of the rods, etc.

In setting the valves upon a locomotive, some means must be provided for turning the driving wheels. The main driving wheels (those to which the connecting rod is coupled) are usually raised and set upon rollers, which can be turned by a hand lever or an electric motor. The drivers can thus be turned without moving the engine. Where such a set of rollers are not available, the engine may be moved to and fro over the track by using pinch bars.

The side rods are taken down, and the connecting rods put in position, as the first step. Then make an accurate measurement of the outside lap of the valve. Next set the valve in its central position on its seat, that is to say, so that the lap on each side extends an equal distance beyond the ports. When this has been done, make a small center-punch mark on the flange of the stuffing box, and, with a fixed tram, make a punch mark on the valve stem. It will always be possible then to set the valve in the central position, even though the steam chest cover may be on.

Next adjust the length of the valve rod. To do this, first set the upper arm of the rocker so that it stands exactly vertical if the valve seat is horizontal. If

CONSULTING DEPARTMENT—(Concluded)

the valve seat is inclined, the arm must be set at right angles to the surface of the seat. Then adjust the length of the valve rod so that it will unite the rocker and the valve without disturbing the position of either.

Next fasten both eccentrics in any position on the axle, and connect the eccentric-rods to the straps and the link, which must be suspended from the lifting arm, with the reach rod and reversing lever in place. Drop the reversing lever into the extreme forward position, and turn the drivers, noting whether the valve has an equal amount of travel on each side of its central position. If it has not, adjust the length of the forward or upper eccentric-rod until such an equalization is obtained. If the valve travels more to the front than to the rear of the engine, the eccentric-rod is too short and must be lengthened. If the excess of travel is to the rear, the rod is too long and must be shortened. Then raise the link to the extreme backing position, and perform the same operation on the lower or backing eccentric-rod. In order to check the accuracy of the work, the links should again be dropped into the extreme forward position, and another test of the valve travel made. The best method of measuring this travel is to use a tram and scribe a line on the valve stem at the extreme points of travel, and measure from these lines to the center-punch mark already referred to.

Spiral and Helical Springs

Question: Kindly explain how to figure dimensions of spiral and helical springs, giving the formulæ for so doing.—*E. S.*

Answer: A spiral spring is one which is wound around a fixed point or center, and continually receding from it like a watch spring. A helical spring is one which is wound around an arbor, and at the same time advancing like the thread of a screw.

The formula for spiral springs of wire ⅜ inch and under, is as follows:

$$\text{Maximum load, pounds} = \frac{12{,}000 \times (\text{Diameter of wire})^3}{\text{Mean radius of springs}}.$$

The work in foot-pounds that can be stored up in a spiral spring would lift it above 50 feet.

For helical springs, the formula is:

$$E = \frac{d^3 \times .w}{D^4 \times C}.$$

E = compression or extension of one coil in inches. The deflection E for one coil is to be multiplied by the number of free coils, to obtain the total deflection for a given spring, d = diameter from center to center of steel bar constituting the spring in inches; w = weight applied in pounds; D = diameter or side of the square of steel bar, in sixteenths of an inch; and C = a constant which may be taken as 22 for round steel and 30 for square steel.

Adjusting Load between Two A. C. Generators

Question 1: Can the load between two A. C. generators running in parallel and driven by the same unit, by either belts or on the same shaft, be adjusted by the field excitation; and if not, how can the load be adjusted?

Question 2: Would it be practical to run two such generators in parallel?

Question 3: Can you tell me where I can get a book describing frequency indicators?—*B. S. H.*

Answer 1: The load can be adjusted by getting the machines into parallel; then loosen the belt of the machine carrying the heavier load, till it slips enough to cause the machines to divide the load properly. If the machines are direct-coupled, and the revolving members are keyed to the same shaft in the proper phase relation, then, when they are paralleled with proper field excitation, they should divide the load proportionately. The chief effect of varying the field excitation is to cause an idle current to circulate between the two machines—which causes heat and poor regulation.

Answer 2: It is entirely practical to run two such generators in parallel.

Answer 3: You should write to the Westinghouse Electric Manufacturing Company, Pittsburg, Pa., for their Instruction Book on Frequency Indicators.

HON. GEORGE F. HOAR,
Senior United States Senator from Massachusetts.

Practical Talks by Practical Men

Extracts from an Address Delivered before the Students of Armour Institute of Technology

By GEORGE F. HOAR
United States Senator from Massachusetts

FOR THOSE WHO AIM HIGH there is time for thoroughness, time to place excellency above speed. Remember that there is something more to live for than money. Turn from the race after this world's goods, the mad fight for greed, to the love of the higher. You may devote yourself to the practical arts, but remember that there is something nobler in a human life. Do not neglect the spiritual side. A man may be ever so rich and ever so skillful, but he does ill who forgets tastes and affections.

I advise you to read some author every day. Read him so well, soak yourself so thoroughly with him, bathe in his wisdom so often, that you will emerge as from a sparkling fountain of purity.

Whom shall you read? There is little need for lengthy discussion on that point, for our tongue is too rich in its singers. Read Wordsworth, sit at the feet of Emerson, or drink at the fountain of Milton, and you will have added to your knowledge of the practical arts the inspiration that helps to develop the spiritual side.

THE "LONDON TIMES" AND THE "NEW YORK TIMES" have been extremely successful in the war news service of their little steamer, the *Hae-Mun*. During the present war in the Far East, the *Hae-Mun*, with a De Forest Wireless Telegraph apparatus, has been able to supply these papers with an exceedingly quick service. At present the *Hae-Mun* has just returned to the seat of naval operations from Nagasaki, Japan, where she had gone to refit and clean up.

Wireless Telegraphy in War

MAYOR HEAD of Nashville, Tennessee, has given some interesting figures with reference to the cost of running a municipal light plant. It appears that the mayor of Chattanooga has been in communication with the authorities of other cities, for the purpose of making comparisons of the cost of lighting.

Problem of Lighting a City

The following statement as to the lighting of the City of Nashville, which he received from Mayor Head, is of much interest:

"The total cost for lighting the city under the contract system had for several years been about $49,000 per annum, and the actual cash paid by the city for lighting the streets and public buildings for the year 1901 was $47,302.75. This gave to the city 382 arc lights, the outages and inefficiencies of which kept the city in a constant broil with the company on the one hand and with the citizens on the other.

"On October 1 the city accepted from its contractors its newly constructed electric plant at a cost of $140,063.73, which included the cost of the site and the building. Additions were gradually made until the total cost had run up to $153,980.66. The actual cost of operating this plant for twelve months has been $35,162.96, which includes interest on bonds, betterment, etc. This is for 630 arc lights and 1,961 incandescent, as against the 382 previously furnished. The total expense of operating the municipal plant from October 1st, 1902, to October 1st, 1903, was $35,162.96. Had the light now being furnished to the city been supplied by the private company under the contract in force at the time the city took charge of its own lighting, it would have cost the city, on a basis of the present number, equal to 822 arc lights, $69,870, or $22,567.25 per year more than the city was paying in 1901, before it built its plant, and $34,707.04 more than it costs now.

"After the city had finally decided to construct this plant, the private company, which was then charging its customers eighteen cents per kilowatt, before the foundations for the city's plant were completed, voluntarily reduced its price to private consumers from eighteen to twelve cents per kilowatt, and contracts are now being made with the private company for a term of years at five cents per kilowatt. The actual cost to the city, using its own plant, for producing electricity during the past twelve months, has been 2.65 cents per kilowatt."

SPAIN will soon be able to boast of the longest aërial cable for transportation, in the world. This cable, when completed, will stretch from Culativi, a point in the Sierra Alhamilla, over 4,000 feet above sea-level, to the coast, a distance of twelve miles. When ready for work, it will prove of immense importance to the iron ore industry of the Province of Almeria. It is claimed that the mines which are to use the cable have been proved to have over a million tons of red hematite. The cost of the cable and the right of way is estimated at $155,000.

Aërial Transportation

IN MARKED CONTRAST with general conditions prevailing in the steel trade, is the extraordinary activity at the plants of N. & G. Taylor Company, at Philadelphia, Pa., and Cumberland, Md. Both of these plants are engaged largely in the manufacture of the "Taylor Old Style" Brand of Roofing tin, and extra

Taylor Tin-Plate

shifts are contemplated to keep up with the demand for this well-known plate. Recent extensive improvements at the plants of the company will provide a much larger output, made necessary by the increasing demand for their high-grade plates. The open-hearth furnaces and rolling mills at the Cumberland works are running full time, the results obtained from their new equipment, installed recently, being adequate to meet all demands.

PRESIDENT ELIOT OF HARVARD is a public man whose views upon any subject are always worthy of consideration. In a recent address to Harvard students, in which he discussed the relation of industry to happiness, we find the following:

Industry and Happiness

"Opportunity for the play of mental powers exists in almost every employment, but in different degrees; and the more thinking and quick judging an occupation calls for, the more interesting it will be. Skill is much more mental than physical, and efficiency demands mental and moral as well as bodily strength. Next, variety promotes interest in labor. Automatic repetition hour after hour cannot be interesting, and therefore is the proper work of a machine and not of man. The trades unions still discourage the introduction of machines which replace human labor, in spite of this plain fact that a man ought not to be employed at a task which a machine can perform. The supreme source of satisfaction in labor is the motive and method of the artist who struggles toward absolute excellence. This spirit ought to go into a great deal of common labor. The artist gets his highest enjoyment in the progress of his work, not only in designing it through his imagination, but in actually doing it with his hands."

THE ART TILE INDUSTRY of the United States is practically new, dating no further back than the Philadelphia Centennial Exposition of 1876. Twenty-five years ago, architects had no conception of the various uses to which the art tile could be put. Since then the advance of this industry has been remarkable. The art tile is now used extensively for flooring, wall decoration, etc. The output in the United States for one year runs up to ten million square feet. From now on a very rapid development of this industry may be expected, as it is only during the past few years that the public has come to appreciate its varied uses.

The Art Tile Industry

FOR SOME TIME the sanitary problem of the sky-scraper has received considerable attention, and now it is pretty well acknowledged that the effect of working day after day in one of these high buildings is extremely injurious to health. To work eight or ten hours a day in a modern sky-scraper, surrounded by other high buildings and situated in a narrow down-town street, means no sunshine, bad light, and poor ventilation. In many offices in these buildings, clerks are compelled to work the year round with an incandescent light over their desks. Some time ago an article in one of our medical journals set forth these facts in strong terms, showing that the lack of sunshine, good light, and fresh air must be added to the fire risk, the darkening of streets, and other evils for which the modern office building is held responsible.

Are Sky-Scrapers Unsanitary?

THE PRESIDENT OF THE SHEFFIELD SOCIETY OF ENGINEERS AND METALLURGISTS, in a recent address, said:

"The engineer of ordinary ability found in electricity a simple means for remedying extravagance in works more readily than by any other method, and consequently welcomed its introduction. In large works, the introduction of a central power station had been a means of doing away with miles of steam pipes connected with the various outlying engines, which caused great loss of economy from condensation. Boilers of high pressure were put down close to the central power station. These, with the electric distribution plant, gave an efficiency of, in many cases, more than 50 per cent ahead of the old conditions of outlying steam engines. The wages of engine tenders were to a great extent saved, as the various motors throughout the works merely required periodical visiting at much less cost than the engine tenders' wages added up to."

Electrical Operation of Works and Factories

The Care of a Gas Engine

A Few Practical Hints Applying to the Operation of the Internal-Combustion Engine

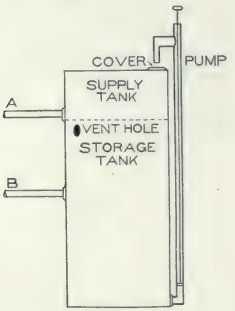
By E. S. LINCOLN

Student, American School of Correspondence

PROBABLY the majority of engine owners and users realize the necessity of cleanliness about the gas engine. The engine should be cleaned and examined immediately after stopping, and allowed to cool down gradually. Oil cans, oily waste, etc., should be kept in their proper places, and the whole engine room should be neat and clean.

Special attention should be paid to the piping, to see that it is properly arranged and all leaks prevented. Cold water should run through the water jacket in a steady stream; but where this is not practicable, the circulating tank and pipes must be large enough for good circulation through the jacket.

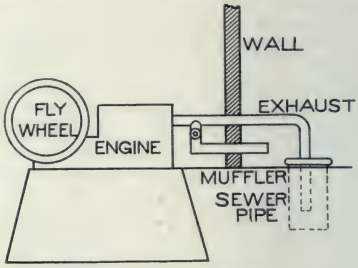
The gasoline should be stored underground, outside of the building. If a small supply can be stored inside, the following sketch shows a simple tank for



SIMPLE GRAVITY-FEED TANK.

supplying small gasoline engines with fuel, on the gravity system of feeding. The upper tank is the supply tank for feeding the vaporizer of the engine through the pipe A; and the lower tank is the storage tank which is connected to the overflow pipe B from the vaporizer. When the supply tank becomes empty, the gasoline can be pumped up from the storage tank to fill it, by means of the pump shown in the sketch, on the right.

Great care should be taken to prevent leakage in the feed pipe, special attention being paid to all joints, which should be



MUFFLER AND CONNECTIONS.

made tight without the use of red or white lead. As the exhaust pipe conveys heated gases, it should be well protected from inflammable material by the use of some non-combustible substance. For a small stationary engine, the accompanying sketch and description of a cheap, but effective muffler may be of interest.

The muffler consists of a piece of sewer pipe about ten inches in diameter and two feet long, set in the ground just outside the wall of the engine room, as indicated in the sketch. The exhaust pipe of the engine enters the muffler through a wooden cover, which is perforated with a number of half-inch holes. A branch is led off from the exhaust pipe, and opens into the air, a valve being inserted near the junction of this pipe with the exhaust pipe. This pipe is for the pur-

pose of relieving the cylinder of back pressure at the time of starting up, and also in case the holes in the muffler cover become closed up with snow or ice between the times of shutting down and starting up. After a few explosions, the relief valve is closed. This muffler has been found to suppress almost completely the sound of the exhaust.

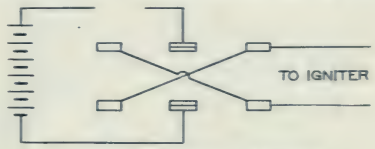
Another "wrinkle" which may be of interest to the reader, consists in supplying a small radiator with the water discharged from the water jacket of the engine, thus cooling the discharged water, and at the same time contributing to the heating of the engine room.

The igniter, which is an important part of the internal-combustion engine, must be well cared for. If it is of the wipe-spark style, the points will wear longer if the polarity of the current is changed from day to day. This can easily be accomplished by means of a double-throw switch connected as shown. This switch may also be used for the main switch. For this type of igniter, storage batteries are, in many cases, too powerful, a small magneto giving better results. It is a good plan to have two sources of current.

It is of great importance that the right kind of oil, and the best grade of that kind, should be used for lubricating the cylinder. Only mineral oil should be used on parts exposed to heat. For other parts, experience shows that a good quality of grease is better than oil, as in cold weather the oil becomes stiff, making it hard to start the engine. Grease is also cleaner, easier to handle, and cheaper than oil.

The quality of the gasoline is also an important factor to be considered, and it is essential that it should be free from water, grit, etc.

In the examination of the engine, which should be done before starting up



CONNECTIONS OF GAS-ENGINE IGNITER.

and after shutting down, special attention must be paid to the governor, to see that it is in good order. All nuts and screws must be tight, and the engine fastened to a very solid foundation.

Always keep the engine in perfect order, and *never* let it get out of repair. There is no reason why the internal-combustion engine should not give perfect satisfaction if properly adjusted and cared for; and nine times out of ten, unsuccessful results are due to mismanagement and neglect.

Paste this in Your Hat

No young man is rich enough to smoke twenty-five cent cigars.

No man, however rich, has enough money to waste putting on style.

The more successful a man becomes, the more careful he should be to keep his head level.

Every time a man loses his temper, he loses his head; and when he loses his head, he loses several chances.

Next to knowing your own business, it's a mighty good thing to know as much about your neighbor's business as possible, especially if he is in the same line.

The secret of all great undertakings is hard work and self-reliance. Given these two qualities and a residence in the United States of America, a young man has nothing else to ask for.

The above are a few of the chunks of wisdom that fell from the lips of the late Gustavus Swift of Chicago, one of the most successful business men of the West. If you do not care to paste these maxims in your hat, pin them to the edge of your looking-glass, and read them every morning while you are dressing. The result may not bring you a million, but in ten years you will possess something that money cannot buy.

Intersections and Developments

An Explanation of Fundamental Principles Useful to All Mechanical Draftsmen and Sheet-Metal Workers

By WILLIAM NEUBECKER

Instructor in Sheet-Metal Pattern Drafting, New York Trade School

Parallel-Line Solids

THE DEVELOPMENT OF SOLIDS means the laying-out flat, of the surfaces of the solids. In Fig. 1 is shown one of the most simple forms to be developed by parallel lines, that of an octagonal prism. This problem explains certain fixed rules to be observed in the development of all parallel forms, which are as follows:

1. There must be a plan, elevation, or other view of the article to be made, showing the line of joint or intersection; and in line with this must be drawn a section or profile of the article. Thus, A B C D shows the view of the solid, A L the line of joint or intersection, and E the profile or section.

2. The profile or section (if curved) must be divided into equal spaces (the more spaces employed the more accurate will be the development), from which lines are drawn parallel to the lines of the solid, intersecting the line of joint or intersection. Thus, from the corners numbered 1 to 8 in the profile E, lines are drawn parallel to the line of the solid, intersecting the line of joint A L from 1″ to 8″. In Fig. 7, where the section A is curved, this is divided into equal spaces.

3. A stretchout line is next drawn at right angles to the line of the solid, upon which is placed each space contained in the section or profile. Thus J F, in Fig. 1 is the stretchout line, which contains the true amount required to enclose the profile E.

4. At right angles to the stretchout line,

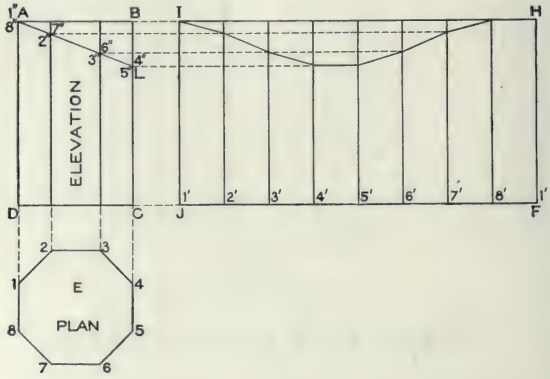


FIG 1.

and from the intersections thereon, draw lines called the measuring lines. Thus, from the intersections 1′ to 8′ on J F, lines are drawn at right angles to the stretchout line J F, which are called "measuring" lines.

5. From the intersections on the line of joint, draw lines intersecting similarly numbered measuring lines, which will result in the shape of the development. Thus, lines drawn from the intersections on the line A L at right angles to B C, intersect similarly numbered measuring lines as shown. Then J I H F will be the development for an octagonal prism intersected by the line A L in elevation.

This simple problem shows the fundamental principles in all parallel-line developments. What has been done is

similar to taking the prism and rolling it out on a flat surface. Imagine the prism with the corners blackened. Starting with corner 1, turn the prism on a sheet of white paper until the point 1 is

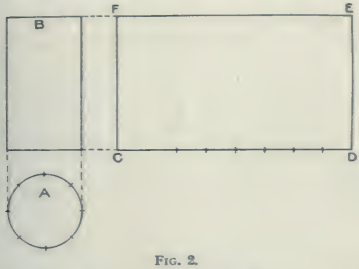


FIG. 2.

again reached; the result will correspond to the development shown. Bearing these simple rules in mind, no difficulty will be experienced in laying out or developing the forms which will follow.

drawing the measuring lines CF and DE, and connecting them by the line FE, we obtain CDEF, which is the development of the cylinder.

Fig. 3 shows how to obtain the development of the surfaces of an intersected hexagonal prism, the angle of intersection being 45°. First draw the elevation ABCD, and the section E in its proper position below. Number the corners in the section 1, 2, and 3, as shown, from which erect perpendicular lines intersecting the plane AB, as shown by 1°, 2°, and 3°. Bisect the lines 1—1 and 3—3 in plan, obtaining the points F and H respectively, and draw the line FH. This line will be used to obtain dimensions with which to construct the developed surface on the plane AB. At right angles to AB, and from the intersections 1°, 2°, and 3°, draw lines as shown. Parallel to AB, draw the line F^v H^v. Now, measuring in each instance from

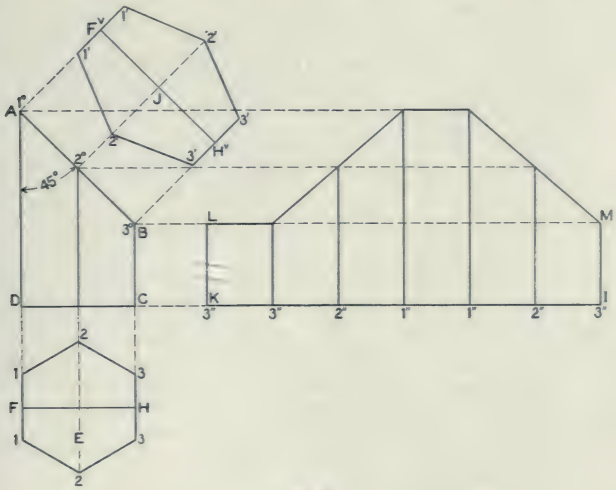


FIG. 3.

Fig. 2 shows the development of a cylinder, and also shows the principles which are applied in spacing circular sections or profiles, as explained for parallel developments. A shows the profile or section, B the elevation, and CD the stretchout line, or the amount of material required to go around the circle. By

the line FH in E, take the distances to 1, 2, and 3, and place them on similarly numbered lines drawn from the plane AB, measuring in each instance from the line F^v H^v on either side, thus obtaining the points 1′, 2′, and 3′. Connect these points by lines as shown; then J will be the true development or section on AB.

For the development of the prism, draw the stretchout line KI at right angles to AD, upon which place the stretchout of the section E, as shown by similarly numbered intersections on KI. From these intersections, at right angles to KI, draw the measuring lines shown; and intersect these with lines drawn from similarly numbered intersections on the plan AB, at right angles to BC. Through the intersections thus obtained, draw the lines from L to M. Then KLMI will be the pattern or development of the intersected prism.

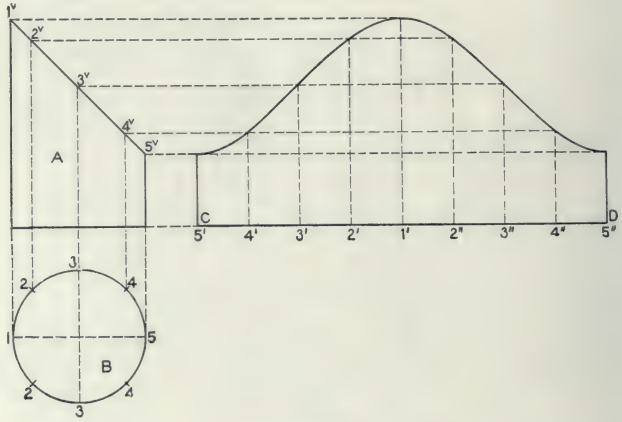


Fig. 4.

Fig. 4 shows the development of an intersected cylinder. A is the elevation and B the profile or plan. As each half of the development will be symmetrical, divide the profile B into a number of equal parts, numbering each half from 1 to 5, as shown. From these points, perpendicular lines are erected, intersecting the plane 1^v — 5^v at 1^v, 2^v, 3^v, 4^v, and 5^v. A stretchout is now made of the profile B, and placed on the horizontal stretchout line CD, the points being shown by 5′, 4′, 3′, 2′, 1′, 2″, 3″, 4″, and 5″. From these points measuring lines are erected, and are intersected by similarly numbered lines drawn from the plane 1^v — 5^v at right angles to the line of the cylinder. A line traced through points thus obtained will be the development of the intersected cylinder. In this case the butting edge or joint line of the cylinder is on its shortest side. If the butting edge were desired on its longest side, it would be necessary to change only the figures on the stretchout line CD, making 1′ start at 5′ and end at 5″.

Tapering Forms

Having described the principles relating to parallel forms, the next subject will be those relating to tapering forms. These forms include only the solid figures that have for a base the circle, or any of the regular polygons; also figures of unequal sides which can be inscribed in a circle, and the lines drawn from the corners of which terminate in an apex, directly over the center of the base. The forms with which the tinsmith has to deal are more frequently frustums of these figures, and the method used in developing these surfaces is simply to develop the surface of the entire cone or pyramid, and then, by simple measurements, cut off part of the figure, leaving the desired frustum. Thus, in the well-known forms of the dipper, coffee pot, colander, strainer, washbowl, bucket, funnel, measure, pan, etc., we have the frustums of cones above referred to. In speaking here of metal-plate articles as portions of cones, it must be remembered that all patterns are of surfaces; and as we are dealing with tin-plate, these patterns

when formed are not solids, but merely shells. In works upon Solid Geometry the right cone is defined as a solid with a circular base, generated by the revolution of a right-angled triangle about its vertical side called the axis.

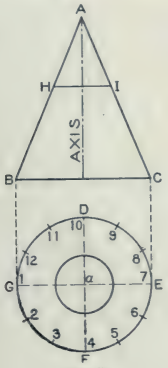


FIG. 5.

This is more clearly shown in Fig. 5, in which is shown a right cone, which illustrates the principles applicable to all frustums of pyramids and cones. ABC represents the elevation of the cone, the horizontal section on the line BC being shown by GDEF, which is spaced into a number of equal parts, as shown by the small figures 1 to 12. As the center or apex of the cone is directly over the center *a* of the circle, then the length of each

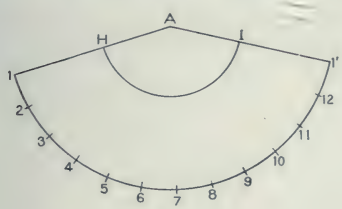


FIG. 6.

of the lines drawn from the small figures 1 to 12 to the center *a*, will be equal both in plan and elevation. Therefore, to obtain the envelope or development, use AB or AC as radius, and with A in Fig. 6 as center, describe the arc 1 — 1′. From 1 draw a line to A; and starting from the point 1, set off on the arc 1 — 1′ the stretch-out or number of spaces contained in the circle DEFG in Fig. 5, as shown by similar figures in Fig. 6. From 1′, draw a line to A. Then A — 1 — 7 — 1′ will be the development of the right cone of Fig. 5.

Suppose that a frustum of the cone is desired, as shown by HICB, Fig. 5; then the opening at the top will be equal to the small circle in plan, and the radius for the pattern will be equal to AI. Now, using A in Fig. 13 as center, with AI as

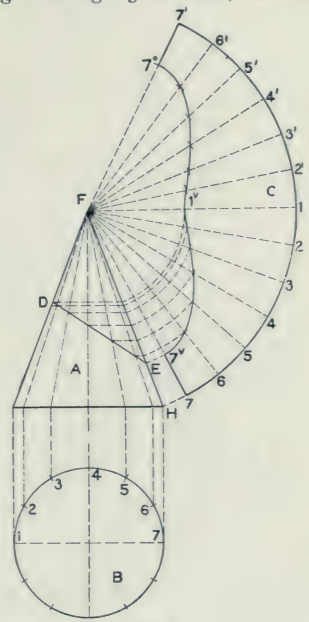


FIG. 7.

radius, describe the arc HI, intersecting the lines 1A and A1′ at H and I respectively. Then H — I — 1′ — 7 — 1 will be the development for the frustum of the cone.

When a right cone is cut by a plane passed other than parallel to its base, the method of development is somewhat different. This is explained in connection with Fig. 7, in which A is the right cone, intersected by the plane represented by the line DE. B represents the plan of the base of the cone, whose circumference is divided into equal spaces. As the intersections of both halves of the cone are symmetrical, it will be necessary

to divide only half of plan B, as shown by the small figures 1 to 7. From these points, erect lines parallel to the axis of the cone, intersecting the base-line of the cone. From these points, draw lines to apex F, intersecting the line DE as shown. From the intersections thus obtained on the line DE, and at right angles to the axis, draw lines as shown,

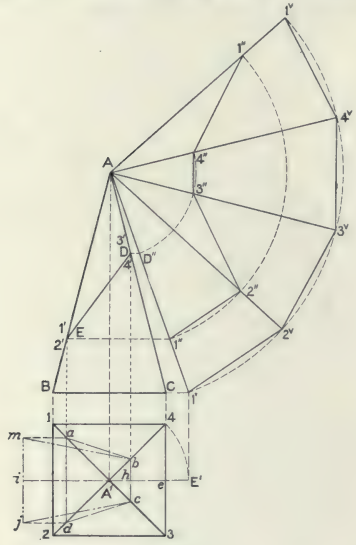


FIG. 8.

intersecting the side of the cone FE. Now, using F as center and FH as radius, describe the arc $7 - 7'$. From 7, draw a line to F; and starting from the point 7, set off on the arc $7 - 7'$ the stretchout of the circle B, as shown by the small figures $7 - 1 - 7'$. From these points, draw radial lines to the center point F; and intersect them by arcs struck from the center F, with radii equal to similarly numbered intersections on the side FH, partly shown by points $7^{v} - 1^{v} - 7^{\circ}$. Trace a line through the points of intersection thus obtained; then $7^{\circ} - 7^{v} - 7 - 7'$ will be the desired development.

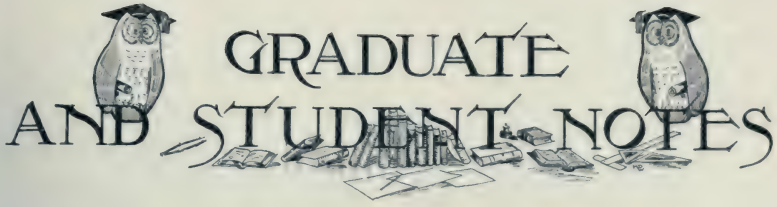
These same principles are applicable, no matter at what angle the cone is intersected.

Fig. 8 shows the principles applicable to the developments of pyramids having a base of any shape. In this case, we have a square pyramid, intersected by the line DE. First draw the elevation of the pyramid as shown by ABC; and, in its proper position, the plan view as shown by 1, 2, 3, 4. Draw the two diagonal lines $1 - 3$ and $2 - 4$, intersecting each other at A'. The length of the line AC represents the true length on $A'e$, but is not the correct radius with which to strike the development.

A true length must be obtained on the line $A'4$ as follows: At right angles to $3 - 4$ from the center A', draw the line $A'E'$; and using A' as center and $A'4$ as radius, describe the arc $4E'$ intersecting $A'E'$ at E'. From E' erect the perpendicular line $E'1^{v}$ intersecting the base-line BC extended at 1^{v}. From 1^{v} draw a straight line to A, which will be the true length on $A'4$, and the radius with which to strike the development. Now, with A as center and $A - 1^{v}$ as radius, describe the arc $1^{v} - 3^{v} - 1^{v}$. Starting from 1^{v}, set off the stretchout of $1 - 2 - 3 - 4 - 1$ in plan, as shown by $1^{v} - 2^{v} - 3^{v} - 4^{v} - 1^{v}$ on the arc $1^{v} - 1^{v}$ ($1^{v} - 2^{v}$ being equal to $1 - 2$, etc.); and from these points draw lines to the apex A, and connect points by straight lines as shown from 1^{v} to 2^{v}, 2^{v} to 3^{v}, 3^{v} to 4^{v}, and 4^{v} to 1^{v}. Then $A1^{v}3^{v}1^{v}$ will be the development of the square pyramid.

To obtain the cut, in the development of the intersected plane DE, which represents respectively the points $3^{1} - 4^{1}$ and $1^{1} - 2^{1}$, draw at right angles to the center line the lines $D - D''$ and $E - 1''$ intersecting the true length $A1^{v}$ at D'' and 1''. Using A as center, and radii equal to $A - D''$ and $A - 1''$, intersect similarly numbered radial lines in the development. Connect these points as shown from 1'' to 2'', 2'' to 3'', 3'' to 4'', and 4'' to 1''. Then $1'' - 1^{v} - 3^{v} - 1^{v} - 1'' - 3''$ will be the development of the intersected square pyramid.

To draw DE in plan, drop perpendiculars from D and E, intersecting the diagonal lines in plan at *b c* and *d a*. Connect lines as shown at *a*, *b*, *c*, and *d*. To obtain the true section of the plane DE, take the length of DE, and place it as shown in plan from *h* to *i*; through *i* draw the vertical line *jm*, and intersect this by horizontal lines drawn from points *a* and *d*. Draw lines from *b* to *m* and *c* to *j*.



Hints for Exposition Visitors

HOW TO SPEND the time at the World's Fair, is a question uppermost in the minds of every person who anticipates a visit to St. Louis this summer. For the benefit of those who are likely to have only a few days at their disposal, we suggest the following tours as being most satisfactory:

On arrival at St. Louis, find a suitable boarding place, preferably not too near the Fair grounds. There are many boarding houses on the west side of town, and many private families have opened their homes to visitors at comparatively moderate prices.

After having located properly, take cars leading to Lindell Entrance, from which the main picture of the grounds is obtained. Choose then from the following four or five days' tours, according to the amount of time at your disposal:

FOUR-DAY TOUR

ESTIMATED COST:	
Board & Room @ $3.00 per day	$12.00
Entrance to Fair, @ 50 cents	2.00
Guide	.25
Souvenirs	2.00
Incidentals	5.00
Total cost	$21.25

Each building, when entered, must be covered systematically. It is well to enter at one end, and to travel around the building in the outside aisles to get a general survey before taking in the separate exhibits in detail.

First Day: Enter the Lindell Entrance, and walk down the west side of Plaza of St. Louis to Cascades and Terrace of States. Crossing through the Terrace, and looking towards Festival Hall, where is located the largest organ in the world, enter the Mines and Metallurgy Building. Here a stop of from three to four hours can well be made. At noon, lunch may be eaten in the cool of the long Cascades, and water obtained from the many drinking fountains. Next should follow the Liberal Arts Building and the U. S. Marine Corps. In the cool of the evening, take a ride on the Intramural Railroad, entering at Station No. 16; and either spend the balance of the time on the Pike or on the comfortable benches of the Plaza St. Louis, listening to the concert of the Innes Band.

Second Day: Again enter at the Lindell Entrance, walk down the *east* side of the Plaza, which goes from the main picture to the Das Deutsche Haus. Here are hung huge chimes, which on occasions peal forth music to be heard in all parts of the grounds. Enter the Education and Social Economy Building, containing exhibits of the various schools and colleges of the United States and foreign countries. Too much time must not be spent here, as it is necessary to hurry on to the Manufactures Building, where the balance of the day, until 5 P. M., is to be spent. The Model City is next in order, and the evening should be spent on the Pike.

Third Day: This is to be a very busy day, and an early start is necessary. Enter at the Administration Entrance, and enter the west end of the Transportation Building. The entire forenoon can well be spent in looking over the exhibits of this palace. Lunch may be eaten in the Plaza of St. Anthony, after which comes the Palace of Machinery. The beautiful exhibits of the Japan Concession follow, and a hurried trip through Jerusalem. The evening may be spent on the Lagoon and at the Sousa Band concert.

Fourth and Last Day: The last day of the tour is to be spent in the Electricity and the Varied Industries Buildings. Again enter at the Lindell Entrance, and walk down west side of the Plaza St. Louis. Notice particularly the monument erected in memory of the Louisiana Purchase, and enter the Electrical Building at the extreme southwest corner. Here is located the exhibit of the AMERICAN SCHOOL OF CORRESPONDENCE. About half of the forenoon may well be spent here, after which comes the Varied Industries Building, in which the balance of the day may be spent. The last evening of the tour should be spent on the Pike.

FIVE-DAY TOUR

1st Day.—LINDELL ENTRANCE:
(*a*) Model City.
(*b*) Liberal Arts.
(*c*) Mines and Metallurgy.
(*d*) Evening ride on Lagoon.
(*e*) Band concert in Plaza St. Louis.

2d Day.—CLAYTON AVE. ENTRANCE:
(*a*) To be spent on Plateau of States (Register in your own State Bldg.).
(*b*) U. S. Government Building.
(*c*) Fisheries.
(*d*) Evening Illumination from Terrace of States.
(*e*) Pike after 9 P. M.

3d Day.—ADMINISTRATION ENTRANCE:
(*a*) Transportation Building.
(*b*) Machinery Building.
(*c*) Boiler House.
(*d*) Jerusalem.
(*e*) Ride on Intramural Railroad.
(*f*) Pike.

4th Day.—ADMINISTRATION ENTRANCE:
(*a*) Agricultural Building.
(*b*) Horticulture.
(*c*) U. S. Life-Saving Station.
(*d*) Sousa's Band in evening.
(*e*) Pike in evening.

5th Day.—LINDELL ENTRANCE:
(*a*) Varied Industries.
(*b*) Ride in Automobile.
(*c*) Electrical Building.
(*d*) Pike.

Recently Graduated

THE FOLLOWING STUDENTS have been graduated from the American School of Correspondence since the last number of THE TECHNICAL WORLD was issued:

Adams, Napoleon A., No. Adams, Mass.—Course: Electrical.

Ashley, Fred S., Florence, Mass.—Course: Mechanical.

Baker, Fred, Hastings, Mich.—Course: Heating, Ventilating, and Plumbing.

Banks, A. L., Los Angeles, Cal.—Course: Electrical.

Barber, Frank W., Erie, Pa.—Course: Stationary.

Beardsley, W. A., Glenwood, Minn.—Course: Mechanical.

Bell, L. J., Plano, Ill.—Course: Electrical.

Bothwell, J. L., Mexico City, Mex.—Course: Heating, Ventilating, and Plumbing.

Boughton, Stanley W., Alma Heights, Mich.—Course: Electrical.

Carroll, H. T., Swanton, Ohio—Course: Electrical.

Copeland, Fred E., Thomaston, Me.—Course: Stationary.

Curry, Harry F., Los Angeles, Cal.—Course: Mechanical.

Deefholts, E. C. R., Formby, West Bank, Lancaster, Eng.—Course: Electrical.

Foote, Nelson S., Haverhill, Mass.—Course: Stationary.

Gery, Clifford R., Greenfield, Ind.—Course: Electrical.

Glosser, J. Frank, Mansfield, Ohio—Course: Electrical.

Green, Jay P., Mound City, Mo.—Course: Electrical.

Hayne, Joseph, Ft. Barrancas, Fla.—Course: Mechanical-Electrical.

Hickin, Wm. D., So. Milton, Mich.—Course: Electrical.

Hooper, Fred E., North Andover, Mass.—Course: Electrical.

Huther, W. F., Canton, Ohio—Course: Mechanical.

Inglis, Dr. H. McClelland, Linwood, N. Z.—Course: Mechanical.

Kiltz, Clyde E., Elgin, Ill.—Course: Electrical.

Patterson, Everett, Ardena, N. J.—Course: Mechanical.

Peterson, P. M., Rock Springs, Wyo.—Course: Mechanical.

Scott, John Oliver, Brooklyn, Iowa—Course: Electrical.

Skeels, W. M., Palmyra, N. Y.—Course: Mechanical-Electrical.

Smyser, Thos. L., York, Pa.—Course: Mechanical.

Symonds, Harry E., Edmunds, Eng.—Course: Electrical.

Wallace, Geo. H., Moorhead, Minn.—Course: Stationary.

Walther, Victor S., Saginaw, Mich.—Course: Mechanical-Electrical.

Wesle, Jos., Camden, N. J.—Course: Mechanical-Electrical.

White, Lewis J., Peabody, Kansas—Course: Electrical.

Second Annual Reception

WHILE THIS NUMBER OF THE TECHNICAL WORLD was in the hands of the printer, the second annual reception tendered by Armour Institute of Technology to the students of the

U. S. SENATOR DOLLIVER, OF IOWA.
Principal Speaker at the Reception, June 17, at Armour Institute.

American School of Correspondence, was held on the evening of Friday, June 17. A full report of the interesting event will appear in the next number of this magazine.

The N. A. S. E.

ON TUESDAY EVENING, May 30, the two Chicago Lodges of the National Association of Stationary Engineers journeyed to 33d Street, and paid a visit to the Armour Institute of Technology and the American School.

After the guests had walked through the laboratories and buildings, and partaken of refreshments in the Institute Dining Room, Dean Raymond, acting as chairman, called upon several gentlemen, and a number of bright, short, pithy speeches were made. Dean Monin dwelt upon the harmony of purpose which existed between what might be termed the "theoretical" man and the "practical" man, as a promising sign of the future.

Mr. F. W. Raven, National Secretary of the N. A. S. E., made a noteworthy statement in the course of his remarks—to the effect that seventy-six per cent of the members of the N. A. S. E. either had at one time been, or are now, students of Correspondence Schools.

To Chicago Students

DURING the months of July and August the School will be open evenings, on Mondays only. The present plan of being open every week-day evening will be resumed in September.

The Land of the Chrysanthemum

THE ACCOMPANYING PICTURE shows the portrait of one of the Japanese students of the American School of Correspondence — Ikukichi Arrow. This young man is an engineer in Tokio. During the present war the studies of the Japanese students have been interfered with, not merely through the holding up of mail, but also as a result of the natural excitement which the war has caused in Japan. At the present writing, several students of the American School are serving with Admiral Togo, and have taken part in the sea fights off Port Arthur. For the last few months, mail matter addressed to students in Korea and at one or two points in Manchuria, has been returned by the postal authorities—an indication that it will be some time before the state of the country will warrant the sending of letters.

IKUKICHI ARROW.

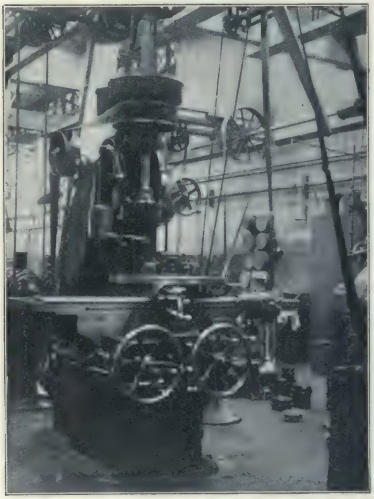
The work of the Japanese students has always been of a very high order; and we are wondering if the manner in which Japan as a nation has taken hold of technical education, has not had a great deal to do with their successes in the war with Russia.

Personal News

H. L. STROM, of South Portland, Me., a graduate of the American School, passed the Civil Service examination for Engineer, with an average of 89. His first work for the Government was the erection of searchlight plants, in preparation

for the war manœuvers held off the Atlantic coast last summer. Two power houses were also put up in two of the new forts; and when the building was ready at Fort Leavitt, Mr. Strom was sent as erecting engineer, and installed three 11 x 19 x 11 Westinghouse compound engines, direct-connected to Bullock generators; a double mechanical draft plant; one Warren outside plunger pump; and one Goubert feed-water heater. Mr. Strom had the station in working order in time for the manœuvers.

Mr. F. C. Brittain, of Chippenham, England, is employed in the shops of the



"My Last Milling Machine"—F. C. Brittain.

Consolidated Tool Company. The accompanying picture of a milling machine is one of the four he was engaged in building.

Mr. C. Bourne, of Hulme, England, has charge of the switchboard department of the Bertram Thomas Electrical Company, Manchester. In one of his letters he says:

"We have lately been developing a new circuit-breaker, and have just had it tested. The breaker was highly commended by the London C. C., for use on a contract which we have from them. Its capacity is 400 amperes. It was repeatedly tested over a short circuit of 2,000 amperes and 500 volts, and passed without damaging either the main or the auxiliary contacts in the slightest."

Hilario Blanch Buil, of Madrid, Spain, one of the American School students in the Mechanical-Electrical course, is a graduate of the School of Art and Industry of Madrid.

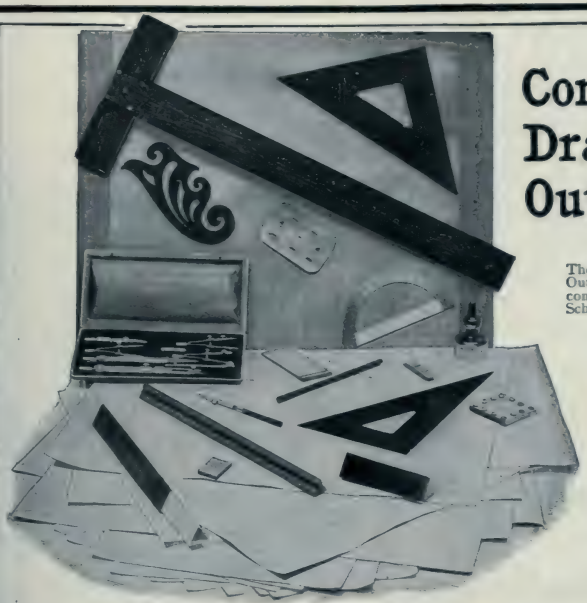
H. Blanch Buil.

We are interested in knowing that Mr. F. G. Ortt has been assigned to the important position of overlooking the installation of all the navigating instruments on board the ships in the Electrical Equipment Department of the New York Navy Yard.

"Teaching an Old Dog New Tricks"

One of the students of the American School recently wrote:

"I have held a marine license since 1878; and I have had charge of nearly everything of 100 tons and under, from a fishing steamer to a Herreschoff yacht, and could get all there was in a boat out of it. Since completing my course in the American School, I have come to the conclusion that for nearly twenty years I was nothing but a starter and a stopper. I really knew nothing of what is most essential for an engineer to know; but thanks to my course, I have now a better insight into the scientific principles of engineering than I ever thought it possible to obtain. The saying that 'it is hard to teach an old dog new tricks' does not always apply, as I was in my 54th year before taking up my studies. At that time I couldn't work a problem in common fractions."



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One Hard Rubber Combination Irregular or French Curve, special,	.65
One Bottle Higgins' Waterproof Ink,	.25
One 4-H Siberian Drawing Pencil,	.10
One Faber's Ink Eraser, No. 1075,	.05
One Faber's Pencil Eraser, No. 111,	.05
One dozen Thumbtacks,	.20
Nine sheets Whatman's handmade, cold pressed, Drawing Paper, 13½x20 inches,	.54
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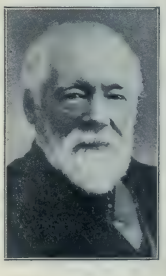

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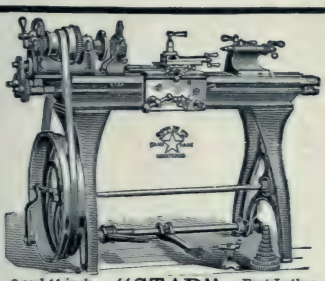

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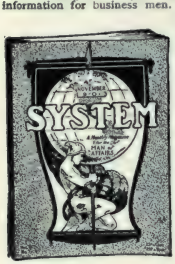

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BOOKS RECEIVED

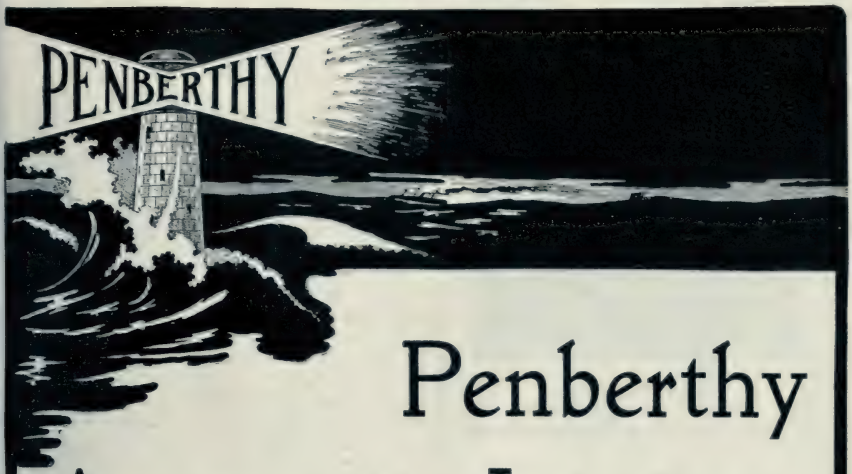
American Renaissance. A Review of Domestic Architecture. Illustrated by 96 half-tone plates. By J. Wheeler Dow, Architect. Wm. T. Comstock, Publisher, New York, N. Y. Gilt top. Price, $4.00.

THE AUTHOR has endeavored to show that the adaptation of the various styles of architecture to the needs of our people, has developed a special style, which he terms "American Renaissance."

We delight to discover that the aborigines of America cultivated art, and that China, Japan, and other "barbaric" nations also cultivated art entirely beyond the province of modern criticism; but the best we have been able to say for ourselves, is that we have always had a regard for art; and when business did not interfere, we have, after a desultory fashion, cultivated it.

Chapter I commences with the "magnificence" of the subject. The present popularity of our early domestic architecture is supposed to be the outcome of a desire for the new and strange, like the newly-invented architecture of the Western States.

The popular idea of American Renaissance would be represented by the sumptuous estates recently erected in great numbers by American millionaires; but according to this latest commentary, most of this modern architecture was designed in defiance of the vital theory of the dwelling-house—namely, the Anglo-Saxon home principle, and it expresses American ostentation more often than American Renaissance. "The odd conceits of captains of industry in the Berkshires," mentioned in Chapter II., relates to this phase of domestic architecture, as does "The Crowding of New York," and the unfavorable comparison that is drawn between the great estates of America and those of Great Britain.



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LITERATURE—(Continued)

The author subdivides the subject into periods, such as "The Grand Epoch," relating to the prosperous time in the American colonies immediately preceding the Revolution; and the "Reign of Terror," exemplifying the culmination point of the outrageous circular work and the cupolas. The chapter on "Adaptation" is particularly interesting, as well as the one entitled "The Ancient Regime—and Andrew Jackson."

The author considers commercialism the main impediment in the way of good domestic architecture in America. In Chapter VII, "The Transitional Period," this influence is minutely traced, whatever good points there were being attractively presented in illustrations of the Colonnade on Lafayette Place in New York City, and other fine old domiciles of the time.

Chapter XI, concerning style, discusses architectural design most picturesquely.

As a book of reference, the work is enhanced in value by a copious index, where every item of interest, every allusion bearing upon the author's theory of architecture has been catalogued. It is something more than an index—a concordance of the text and diagram of the subject. The selection of illustrations is especially noteworthy, embracing many rare and beautiful examples of American domestic architecture, which are placed here within reach of the public for the first time; while the old favorites, such as Mount Vernon-on-the-Potomac are well represented. The engravers' work and letter press are admirable, and the binding eminently appropriate.

Electricity and Matter. By J. J. Thomson, D. Sc., LL. D., Ph. D., F. R. S. Pages 162. Chas. Scribner's Sons, Publishers. New York. Price, $1.25

THIS BOOK is made up of lectures delivered by the author in 1903 at Yale University, and discusses the bearing of the recent advances made in electrical science on modern views of the constitution of matter and the nature of electricity. As the author states, these two questions are probably so intimately connected that the solution of the one would supply that of the other.

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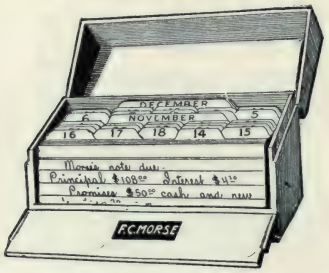

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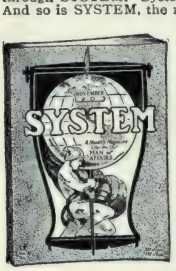

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The treatment of these subjects must of necessity be somewhat technical; but, as far as possible, the author has avoided mathematics; and the treatment is, as a whole, comparatively easy reading. The subject is first approached from the standpoint of the representation of the electric field by lines of force. Electrical mass is also treated, and the effects due to the acceleration of the Faraday tubes. The chapter on Radio-Active Substances is particularly timely, and will doubtless be of much interest to the general public.

New York Air-Brake Catechism. By Robert H. Blackall, Author of "Westinghouse Air-Brake Catechism." Published by Norman W. Henley Publishing Company, New York. Pages 250. Cloth. Price, $1.25.

THIS BOOK is designed to give detailed information on the New York Air Brake. The various devices used are explained in question-and-answer form, thus making the work valuable to those intending to take examinations. Seventy-five engravings illustrate sections of the details, the parts being numbered for reference. The subjects treated are: Triple Valve, Engineers' Valve, Pump Governor, Piston Travel, Retaining Valve, Signal System, Water Brake, Train Handling, Braking Power, and Leverage.

Logarithms for Beginners. By Charles N. Pickworth. Pages 48, 12mo. Cloth. Published by D. Van Nostrand Company, New York. Price, 50 cents.

THE TREATMENT of logarithms in ordinary textbooks on Algebra and Trigonometry is often unsuited as an introduction of the subject to the beginner, assuming too much as to his mastery of root principles which he may have grasped but insufficiently. It is the purpose of Mr. Pickworth's little volume to remedy this defect, giving full detailed and practical explanation of logarithms and their various applications. In particular, the ordinary difficulties that beset the student in connection with negative characteristics, are here fully elucidated.

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Modern Electricity. By James Henry, M. E., and Karel J. Hora, M. Sc. Pages 355. Laird & Lee, Publishers, Chicago, Ill. Price, $1.50.

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Other subjects taken up are: Electric Railways, Electric Lighting, The Telephone, The Telegraph, Wireless Telegraphy, Electro-Chemistry, and the X-Rays.

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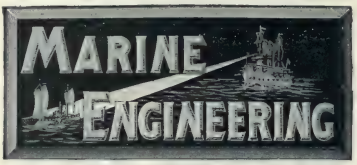

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LITERATURE—(Continued)

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MAGAZINES

Ice and Refrigeration (June)—Chicago

THE LEADING ARTICLE in this number is "Keeping Cold Stores Clean," by Madison Cooper. Cold-storage rooms, when empty, are frequently neglected, although well cared for when filled with meat, fruit, or vegetables. Just what to do to make the rooms clean and suitable for cold storage, is well explained in this article. It includes a discussion on how to make and apply whitewash, the advantages of cold-water paints, ventilating and drying, etc. Another article is that by T. R. Wingrove on "The Ammonia Condenser." It gives an engineer's experience during two days of different temperature. The conclusions regarding proper size and management are excellent.

Other articles are:

Cooling of Milk and Cream, by London M. Douglas.
The Distilling Apparatus, by J. C. Bertsch.
Natural Ice Business.
Temperature for Fruit Storage.

Power (June)—New York

MR. W. H. BOOTH, in his article on Economizer Calculations, shows how to determine the percentage of gain from the use of an economizer. The value of the more common use of the heat unit is carefully pointed out. The important, but little understood, entropy diagram is explained in a simple manner in an article, "The Entropy Diagram and Its Uses," by H. Boyd Brydon. The usual treatment of entropy involves a mass of mathematics which, even after much labor, conveys but little information. The idea of the writer is to show how the entropy diagram can be drawn as easily as the indicator diagram.

The practical letters always contain items of interest. Among these letters in this number, should be mentioned those on "The Point of Ignition in a Gas Engine;" "Water Packing for Centrifugal Pumps;" "Division of Work in the Boiler Plant;" "Getting Rid of Cylinder

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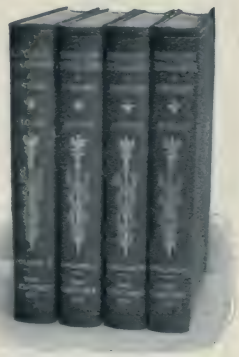

Editorially, mechanically, and artistically this work is a wonder. It is the only complete, *impartial* account of the great Emperor's life. All others have tended toward hero worship or erred to an equal extent on the other side. Professor Sloane was thoroughly equipped for this work through exhaustive study of all the Napoleonic literature obtainable and by extensive travel over the scenes of Napoleon's struggles, affluence, and subsequent downfall.

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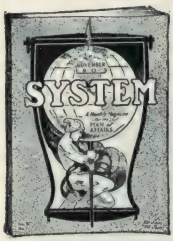

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LITERATURE—(Continued)

Oil in Boilers;" and "Gas Engine Design."

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Power Pumps, by W. E. Crane.

Electric Power Plant of the Liverpool & Southport Railway, by Frank C. Perkins.

A Compact Home-Made Throttling Calorimeter, by H. J. Travis.

Strainers, by W. E. Crane.

Indicating the Gas Engine, by C. E. Sargent.

The Engineering Record (June 4)—New York

ALTHOUGH much has been written regarding the Panama Canal, one of the most interesting phases is discussed in this magazine. Dr. W. C. Gorgas, Assistant Surgeon-General of the United States Army, has recently conducted investigations on the Isthmus, and has outlined a plan by which the sanitary conditions there may be improved. The plan resembles that followed at Havana.

"The Water-Supply System of St. Louis," by W. E. Rolfe, is excellent. A general outline follows the historical portion. By means of a map and many half-tone pictures, the reader gets a fine idea of the system.

Other interesting articles are:

The New Electric Works at Neuchâtel, Switzerland, by A. Steere.

A French Breaking Test of Reinforced Concrete Bridge Trusses, by Leon S. Moisseiff, American Society of Civil Engineers.

The Zoelly Steam Turbine.

Air-Lift Pumping Machinery at the Inverted Siphon of the New Croton Aqueduct, New York City. No. II.

Efficiency of Rotary Cement Kilns, by Dr. W. Michaelis, Jr.

Electric Locomotives of the New York Central Railroad.

Amateur Work (June)—Boston, Mass.

"A SAILING DORY," by Carl H. Clark, is the first article in this issue. Full directions for laying out the work are given. Number IV in the series on Pattern Making, by F. W. Putnam, takes up the face plate, a 3¼-inch hand wheel, and a 5¼-inch cone pulley.

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LITERATURE—(Continued)

The Railway and Engineering Review (June 4)—New York

THE ISSUE of June 4 gives an interesting description of the new electric locomotives which are being built for the New York Central & Hudson River Railroad at Schenectady, by the General Electric Company and the American Locomotive Company. These locomotives differ essentially from the ordinary in that the motors are bipolar and gearless. The magnetic circuit, field windings, and motor poles are integral with the locomotive frame.

It is required that the electric locomotive be able to run from Grand Central Station to Croton, without a stop, in 44 minutes, this being equivalent to the present rate of the Empire State Express.

An interesting discussion is given upon Experiments with a Lathe-Tool Dynamometer, from a paper read by J. T. Nicholson at the joint meeting of the A. S. M. E. and the I. M. E. at Chicago, June 1, 1904.

Among other subjects touched upon are:

The display made by Japan at the St. Louis Exposition.

Meeting of the Mechanical Engineering Societies.

Metal Water Tanks on the New Orleans Northeastern Railway. Etc.

The American Electrician (June)—New York

THIS NUMBER is fully up to the usual standard of this excellent publication. As usual, it contains a typical electrical installation, this one being the generating plant of the Kansas City Electric Light Company, fully illustrated and with diagrams.

A valuable discussion by Dr. Louis Bell is entitled "A Revolution in Prime Movers," in which he discusses the steam turbine, the gas engine, and the steam engine. The author predicts that the gas engine will shortly become a very dangerous competitor to the turbine and the ordinary steam engine.

"Furnace Fittings for Steam Boilers," by R. T. Strohm, is interesting. Considerable space is devoted to the Louisiana

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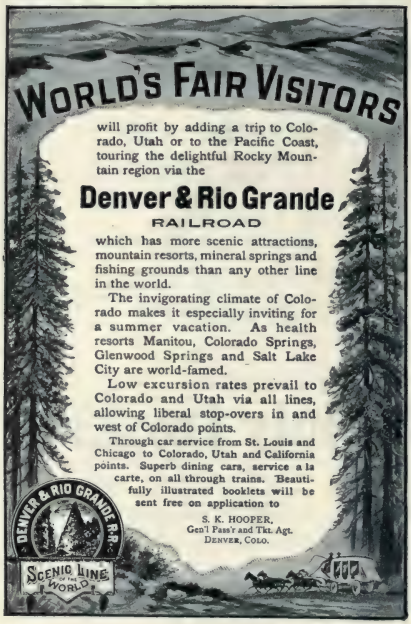
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Other articles worthy of notice are:

Curve Drawing or Graphic Recording Instruments, by H. W. Young.

The New Substation at Helena, Montana.

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Engine-Room Management.

Testing Recording Wattmeter.

Pelton Water-Wheel Company's Testing Room.

The Wiring of Exposed Steel Frame Buildings.

The Engineer (June 1)—Chicago

THIS NUMBER is the Electrical Convention number, and deals almost wholly with electrical apparatus. A very large part of the magazine is devoted to arc lighting. The series alternating-current arc-lighting plant in the Union Stock Yards is fully described with cuts of the apparatus, plan of the plant, wiring of the switchboard, etc.

A very interesting article is that on Alternating-Current Arc Systems, by Richard Fleming. Numerous diagrams are shown, among them being that of the constant-current transformer, the connections of the shunt lamp, the series-condenser system, and the standard 110-volt lamp for parallel work. Two articles are devoted to photometry. The discussion on types and peculiarities of arc lamps is an instructive one.

Among other articles are:

Series Alternating-Current Arc Lighting by the General Incandescent Arc Light Co.

Western Electric Co.'s Series Alternating-Current Arc-Lighting System, and its Application.

Westinghouse Series Alternating Arc-Light System. Etc.

CATALOGUES

Jones & Lampson Machine Company, Springfield, Vermont. Pages 100. Paper, 6 by 9 inches.

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LITERATURE—(Continued)

Vindex Electric Company, Chicago, Ill. Pages 32. Paper, 6 3-4 by 7 inches.

CATALOGUE describing transformers. The transformer is well illustrated. In addition a few pages are devoted to a discussion of Magnetic Iron, Constant-Potential Arc Lighting, Alternating-Current Power, Use of Oil, and Connections.

Ford Automatic Boiler Cleaner, St. Louis, Mo. Pages 90. Paper, 5 by 7 inches.

THE FORD BOILER CLEANER is a double-action skimmer for mechanically collecting solid particles that may float on the water. The solid matter thus collected is blown off through the blow-off pipe. The cleaner is easily placed in multitubular and water-tube boilers. In addition there are many facts regarding engineering.

Wesco Supply Company, St. Louis, Mo. Catalogue of Electrical Goods. Pages 700, 7 by 10 inches. Cloth.

IN THIS CATALOGUE may be found description, illustration, and price of almost everything electrical. In fact, the company states that it can furnish everything in the electrical line from a door-bell outfit to a complete central station, and from a toy motor to a street-railway plant from generator to track bolts.

Arguto Oilless Bearing Company, Wayne Junction, Philadelphia, Pa. Pages 32. Paper, 4 by 7 inches.

CATALOGUE describing bearings made of wood which has been chemically treated. The bearings require no oil or other lubricant. The Arguto bearing is especially suited to textile machinery, and in places where oil is objectionable.

Duluth Stoker Company, Duluth, Minnesota. Pages 16. Paper, 3 1-2 by 6 inches.

BOOKLET describing Duluth Stokers. This form of stoker employs an endless belt of grate bars which lie crosswise in the furnace. The parallel bars are carried by endless chains.

Crescent Machine Company, Leetonia, Ohio. Pages 24. Paper, 5 by 7 inches.

CATALOGUE of band saws for foot-belt drive and motor drive. This company

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The following are the titles of some of the articles that have appeared in recent issues:

How to Read Drawings.
How to Use Logarithms.
Simple Experiments on Strength of Materials.
Hints for Draftsmen.
Workshop Graphics.
Invention and Discovery Not Made by Accident.
How to Become a Good Draftsman.
Why Mechanics Should Study the Strength of Materials.
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Government Employees.
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Chemistry as a Study for the Mechanic.
Hints on Writing for the Press.
"More Bibles than Text Books."
How to Make a Photometer.
How to Obtain Government Publications.
How to Make Experiments.
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LITERATURE—(Concluded)

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The Lunkenheimer Company, Cincinnati, Ohio. Pages 208. Paper, 5 by 7 inches.

CATALOGUE of valves, whistles, gauges, fusible plugs, injectors, sight-feed lubricators, oil cups, etc. This catalogue is well illustrated and indexed.

K. Dykena & Son, Grand Rapids, Mich. Pages 24. Paper, 6 by 9 inches.

CATALOGUE describing stonemaking, including the making of the moulds, the composition of the material, and the handling of the blocks. The catalogue is well illustrated with half-tone engravings showing methods of moulding, finishing blocks, chipping the face, and laying the stone. A very interesting catalogue, especially to architects, civil engineers, and builders.

H. W. Johns-Manville Company, New York, N. Y. Catalogue A, "Asbestos." Pages 100. Paper, 4 by 6 inches.

THE ILLUSTRATIONS of the numerous uses of asbestos are of much interest. Among the uses may be mentioned pipe coverings, boiler coverings, packing, sheathing for buildings, gloves, table covers, torches, theater and fire-place curtains, blocks for jewelers, etc.

This well-known company has also sent us its Catalogue R, "Asbestos Roofing," pages 35, paper, 4 by 6 inches. This catalogue illustrates the uses of asbestos strips for roofing, water-tight floors, electrical insulation, etc.

Hammacher, Schlemmer & Co., New York, N. Y. Catalogue No. 114. Pages 100. Paper, 5 1-4 by 7 1-2 inches.

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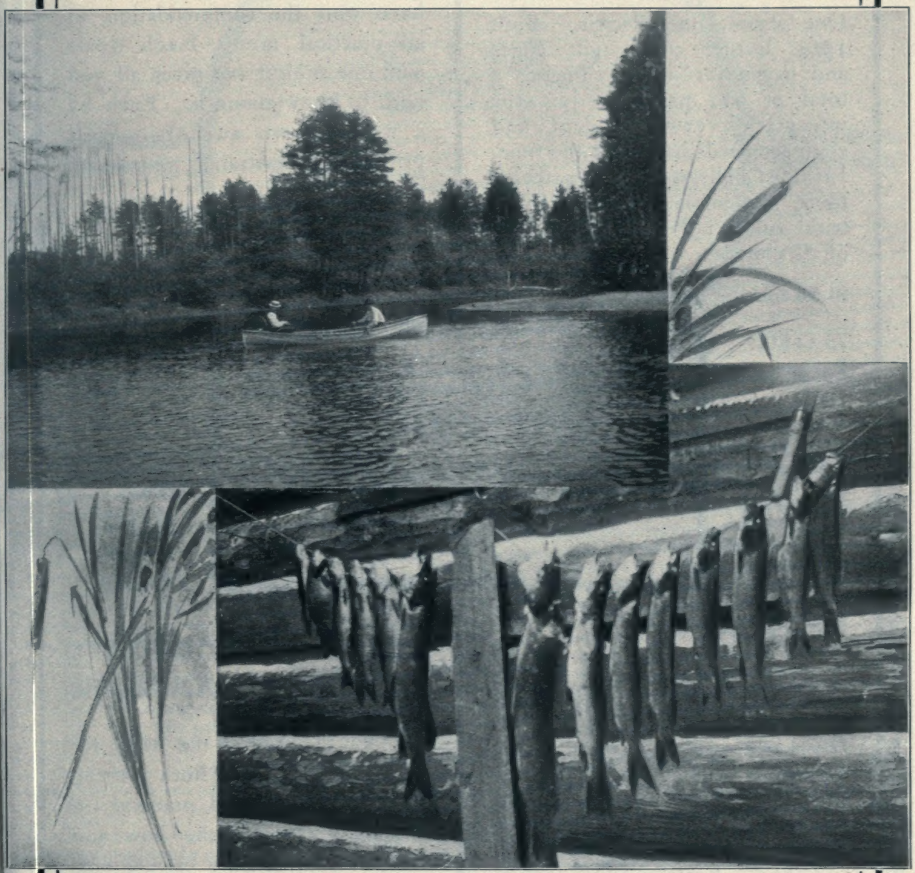

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